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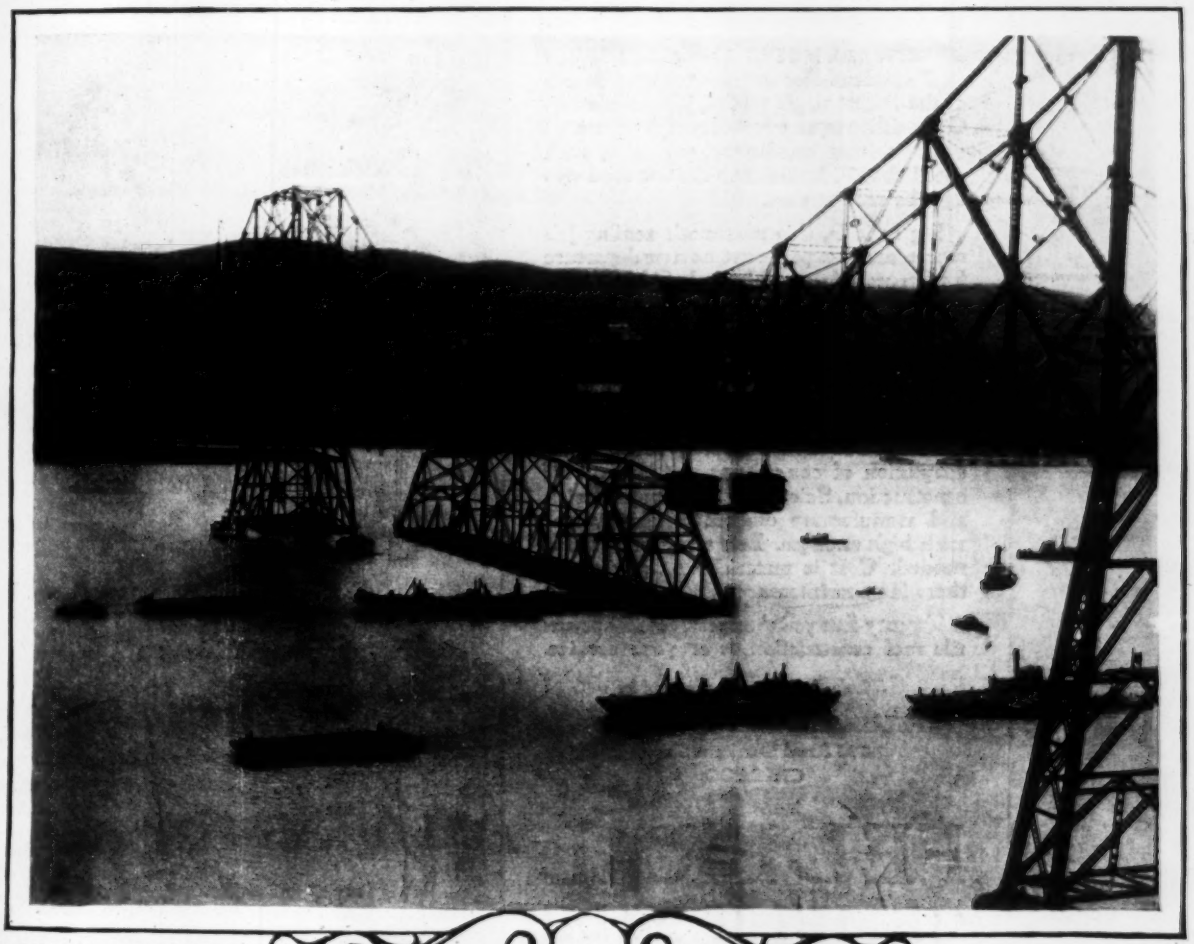

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Handling Landslides on Mountain Roads—Staff Report of Railway Engineering Convention —Three Articles on the Colorado Delta—Density of Concrete and Water-Cement Ratio

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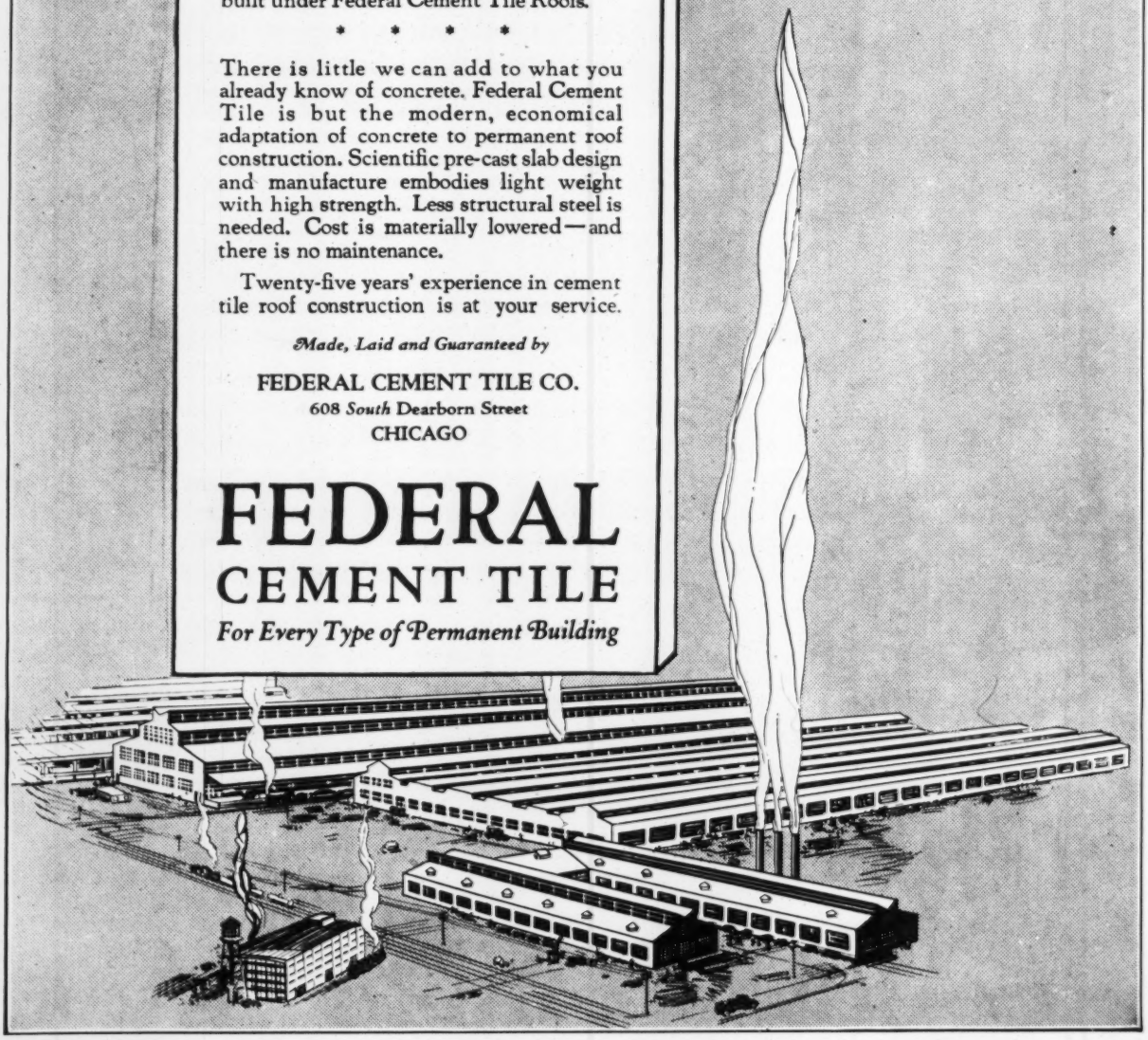

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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FRANK C. WIGHT
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To Put Life in the Barge Canal

ANOTHER effort to apply artificial respiration to the New York State Barge Canal is under way at Albany. A bill is proposed which would provide that if the state should abandon the canal or should transfer it to the federal government for a ship canal the Court of Claims would be authorized to adjudicate damages sustained by canal craft owners because of such abandonment. The proposal has the merit that it recognizes one of the reasons why more new equipment is not going into the canal, namely, that private capital is afraid to invest in carriers when there is prospect that the canal may be abandoned. But this is rather putting the cart before the horse. The reason why the canal may be abandoned is that the prospect of its being a paying proposition for carriers is so dim. For every prospective operator who hesitates because he fears that the canal may go out of business before he realizes on his investment there are ten who hesitate because they doubt that they can make money with the canal in full and continuing operation. And if there is anyone who is keeping off the canal because he thinks the state is going to sell it to the United States for a ship canal he must have in mind some type of equipment that is peculiarly resistive to wear and obsolescence. The New York State Ship Canal has all the substantiality of a Conan Doyle ectoplasm. There are those who profess to be able to see it, but to ordinary and to expert vision it is non-existent.

Earth Slips

EARTH slips and subsidences continue an intractable engineering problem. Forty years ago, perhaps, we write solely from memory, the English engineer Newman collected examples of these phenomena into a book and told of ways in which they had been checked or repaired after occurrence. He confessed lack of knowledge for prediction. Today our attempts at prophecy are nearly as futile. When slides occur we are better prepared with materials and tools quickly to repair the disaster, but in predicting their occurrence, extent and location our situation is but little better than was that of Newman and his predecessors. Our advantage is that we have the means and recently have developed a disposition to search into the fundamentals of subsoil stability and movement. Very largely this study has been prompted by our activities in road building. More specifically in certain regions earth slips have become a major hazard on mountain roads. In this issue, the conditions and practices in one of these regions, the highlands of western West Virginia, are described. Almost the same tale can be told of the roads across the river in southeastern Ohio. The slip occurs and the remedy is undertaken and the maintenance engineer awaits the next slide with certainty that it will come along sometime at some place but with no fore-knowledge of when or where. It is to give some ability to predict that Ladd and Terzaghi and other experts of the Bureau of Public Roads are now surveying these slides and making soil and water studies to arrive, if possible, at fundamental causes. Until these are got at and the engineer can apply his checks and preventives when the road is built and not afterward when the road has been destroyed, his problem has been only partly solved.

Remember the Layman

ENGINEERS concerned with valuation have to prepare estimates with an eye to the quick-witted lawyer who will start to analyze them in open court. Recently the truth of this has been brought home in the case of a railroad's application for increased passenger rates. The engineer who prepared the railroad's valuation, the basis of its arguments for increased rates, when placed upon the stand was not very successful in justifying the high value of several thousand dollars which he had put upon old wooden cars because the opposing lawyer discovered that they were similar to other cars sold recently for a few hundred dollars. The total amount in question was relatively small. It had no appreciable effect on the total valuation but it gave the opposing lawyer just the kind of a point he needed for use in arguing that the carefully prepared estimates were much too high. The analysis of the value of the property was correct as among experts. But that was not enough. It was vulnerable when attacked by non-experts, and such a valuation more often than not must stand or fall upon the opinion of laymen. The engineer engaged in this kind of work cannot afford to take the attitude, fairly common to all experts, that the layman is a negligible element.

More Study in Concrete

ANOTHER chapter in the current concrete proportioning discussion is contributed by F. R. MacMillan in the paper which is abstracted on other pages of this issue. It will be noted that the author takes his stand firmly on the principle that density is independent of aggregate, except as the character of the aggregate, mainly its grading, affects the workability of the concrete. What makes a dense concrete, and therefore an impervious and long-lived concrete, is the quality of the cement paste which in turn is a function of the water-cement ratio. In contravention to this theory we have numerous experimenters who point out that the quantity of the aggregate, and its grading, do affect the strength and presumably the density of the concrete. To this Mr. MacMillan would doubtless reply that they affect the concrete solely by virtue of their effect on its workability, always assuming the aggregate to be sound in itself. It is a nice question, that will be further illuminated by

test and discussion. But it is an indication of the liveness of the thinking in concrete, which is being reflected in the greater care in the study of the material and the resulting higher quality of the work on which this study is being put.

Killing Off Discussion

CHANGING the method of procedure in order to stimulate discussion of committee reports was not considered by the American Railway Engineering Association at its convention last week, despite the attempt of one committee to force the subject upon the meeting by substituting it for assigned subjects. The committee was not permitted to submit its report, was declared to be out of order and dismissed. The procedure was in strict accord with the rules of the association, but the incident serves to indicate that at least some members feel that the present method of procedure can be improved upon, and it would seem that no harm would have been done by departing from established rules in order to get an early expression of opinion from the association at large. The conservative element of the association points to the past record and increasing attendance at the meetings as proof that the present method is all that could be desired. That is a strong argument. Nevertheless, the fact remains that the greater part of the work of the association is being carried on by a few men in each committee and last week's meeting showed that something more than time for discussion is needed because meetings closed considerably ahead of scheduled time without discussion of committee reports, even when the chairman asked for discussion of important subjects. Lack of discussion at these general sessions is, in itself, no better indication of lack of vitality than is mere increase in numbers a sure sign of real health in this or any other society. But it is certain evidence that a few men are conducting the business of the organization and are arriving at conclusions which should be arrived at only after they have been considered by the association as a whole if it is to adhere to its method of procedure in fact rather than in form as at present. As we noted in comment on this same subject some weeks ago the A.R.E.A., and many other technical societies, may well consider a democratization of procedure which will insure discussion.

Colorado Delta Implications

THE great fight in the closing days of Congress two weeks ago over the Boulder Canyon bill justly draws the whole nation's attention to the Colorado River. For the large majority the project remains unintelligible. Its issues are so intricate and have been so extensively juggled and disputed that their merits are hidden in a dense jungle of claims and counterclaims. A group of articles which we present this week throws a beam of light into the heart of the subject: The conditions in the Colorado delta.

Two functions are performed by these articles. First, they direct attention to the primary purpose of the storage project, namely, to control the dangerous instability of the river's course through its delta plain. Second, they give, for the first time, a picture of delta conditions complete enough to make the problem tangible. Full survey data enable a practical judgment of present and future needs to be formed.

There has been much talk of the project being a disguised government power development scheme, or a plan to benefit or harm certain states or certain interests. Those who think this way, or who do not realize that the Boulder Canyon project rests first and foremost on the dominating necessities of delta regulation, can obtain a clearer view through these articles.

It is necessary to remember that a great stream of mud pours out into the delta region constantly, filling up the low places in the landscape, backing up the river and deflecting it hither and thither, and always keeping it on the highest ground of the divide between the gulf and the fertile plains of the Imperial Valley, far below sea level. Low-water periods alternate with great floods, during which the river scours and noses its way around in the soft ground. Levees cannot be made strong enough to resist flood attack; desperately active emergency work is required in flood time to hold them. The ever-present danger is that a levee break may turn the whole river flow down toward the Salton Sink and allow it to dig a deep, almost irreclaimable course in that direction, drowning out a population of many thousands and destroying hundreds of millions of property. Lasting security from this menace will not be achieved until the river's flow is regulated and its burden of mud held back.

Many assert that the danger is immediate, while others as forcibly deny this. The facts now given make possible closer judgment on this point than could be formed heretofore. Five years ago the Pescadero Cut was dug, deflecting the river southward into low ground; in the preceding twelve years the Bee River channel, followed by the Colorado since it broke out westward from its old direct course to the south, had been built upward at the rate of a foot a year, and had become threateningly unstable. The cut made a vast area available for deposition of the river's annual mud burden. Yet in 1925 the levee just above the Pescadero Dam was scoured out, and last year a breach occurred some eight miles farther down, showing that peace was not obtained. Both breaks happened in very small floods, moreover. If 1927 should bring a great flood, will it be as easy to close a breach?

The question mark is inevitable; and yet it may fairly be concluded that the river can be held in its present course, without excessive risk or difficulty, for some years to come. It has not yet begun to back up or raise its bed noticeably. For four or five years—some are bold enough to say for ten years—the river can be held, despite floods and silt deposition. It is always assumed, of course, that nothing will occur in this corner of Mexico to interfere with continuous watch of the river and prompt emergency operations.

But beyond this short period there is no safety along the river. We have a few years of grace, but when they are over we must have the river controlled and equalized and its great mud burden held back. That, in simplest form, is the reason why a huge storage reservoir is necessary, and necessary at once. If safety through storage is to be available early enough it must be built without delay.

Beyond this point, various objections have been intruded into the case, which to many people seem insuperable. But whoever is far enough from local influences to have due perspective, and especially the engineer, will find that they can be brushed aside.

Testimony given in the elaborate Senate hearings on the bill a year ago answered them effectively.

It is urged, for example, that a pure flood detention dam should be built, without provision for complete flow equalization or for irrigation supply, and above all without power development. In the same connection it is urged that Boulder Canyon is the wrong site, in fact that it has fatal defects. But the truth is that adequate flood control and silt detention require so large a storage as to give effectively complete equalization, and the whole undertaking is so vast that to confine it to one purpose when several or all may be served in combination would be an inexcusable error. It would be equally wrong to eliminate power development from the scheme when power in very large amounts will be an inevitable by-product. And as to site, the weight of authority supports a location in Boulder Canyon, and its opponents have never shown other sites to be as satisfactory.

The Colorado River compact for division of water between upper and lower states is part of the bill. Arizona therefore opposes the bill because the compact deprives it of water; Utah opposes because the rights of Arizona would survive despite passage of the bill and Utah might in time be robbed of water. The two claims largely destroy each other. But even apart from this, it is pertinent to point out: (1) That the bill would be just as good (or as bad) whether or not it embodies the compact, and all state interests would be equally secure or the opposite; and (2) that while the compact is obviously inequitable, its inequities are far from being vital and are capable of later adjustment.

Power royalties are demanded by the contiguous states; the states hold that they are deprived of their due if they are not allowed to tax the power produced at the dam. This is the least appealing of all the objections. Arizona has been the most insistent of the power-royalty claimants, to the extent that it has never made clear whether its opposition really rests on need for water or desire for an unearned power revenue, which is a by-product of other insistent capital expenditure.

Those who hold that power development must be left to private enterprise have opposed the Boulder Canyon bill strenuously. It is not clear whether they object to the government's building a dam, at which, of necessity, power will be developed, or whether they merely object to the government's building a powerhouse. But the fact is that the bill does not contemplate that the government shall go into the merchandising of power, and the entire power-enterprise part of the project will therefore necessarily be private, except insofar as municipalities or states may make superior competitive bid for the power produced, a principle embodied in the federal water power act.

In summary, it may be said that the essential needs of the case call for a storage so large as to bring all phases of river utilization into the project; that the bill as drawn reasonably protects every equity and leaves Arizona free to pursue its own appropriation and use of Colorado River water, so far as may prove practicable; that the bill does not tend to introduce the government into the power business but provides for free and fair distribution of the power output according to the natural commercial needs of the southwest; and finally, that if the effect of the bill is to charge the entire cost of the dam against power and none against irrigation or flood protection—a question not yet clarified—no serious matter is involved. Academically, it may be an unfair arrangement, but it will affect but little the use or distribution of the power.

Before the next session of Congress the bill may be amended to meet some of the just criticisms against it, but amended or not the situation in the delta is such that it should be passed as soon as possible.

Milwaukee Water Rate Decision

OUTSIDE of Wisconsin few municipally-owned water-works are subject to regulation by state utility commissions. This fact adds interest to the ruling of the Wisconsin Railroad Commission on the water rate schedule of Milwaukee, abstracted at length elsewhere in this issue. Two notable features of the Milwaukee schedule, which was approved despite protest by many large water consumers and despite several criticisms of basic matters by the commission, are that the same meter rates are charged to large and small consumers and that the city pays the water department only $10 a hydrant for fire protection.

The commission's ruling on these and a number of other points illustrates the complications that enter into rate cases generally, whether private or municipal works are concerned. Some of these complications, in the Milwaukee case, are due to municipal ownership in general, as viewed by the Wisconsin commission, and some are purely local. Among the latter, the city's contention, to which the commission agrees, was that although there is only one meter rate the large consumers really pay much less per unit of water consumed than do the small ones. The commission also accepts certain local conditions as justifying the low hydrant rental of $10 a year—which though far below the cost of service is, we may interject, much more substantial than the zero credit given to most municipally-owned works. Here, as in many other parts of the commission's opinion, much latitude is given to what is called "managerial"—more properly legislative—"discretion." Although the commission does not draw comparisons between what is proper under public as compared with private ownership, it appears that it recognizes a material difference. Thus, while holding that the city is entitled to an 8 per cent return on the rate basis, and is not getting it, the commission permits the city to exercise its discretion in that matter.

In the final analysis, cities owning water-works, the commission seems to hold, may fix rates much as they please, provided that the rates are not unjustly discriminatory. Under private ownership, commissions and courts are deeply concerned with questions bearing on fair return and confiscation.

If it seems to any who read the Milwaukee decision that state regulation where so much "managerial discretion" is allowed is futile, they should remember that had the commission found gross abuses it would doubtless have ordered their correction. Moreover, the adverse criticisms may bear fruit sooner or later. On comparing conditions disclosed by this case with the far less favorable ones common to hundreds of municipal works, one may well wish that all municipal water-works were under the jurisdiction of public service commissions.

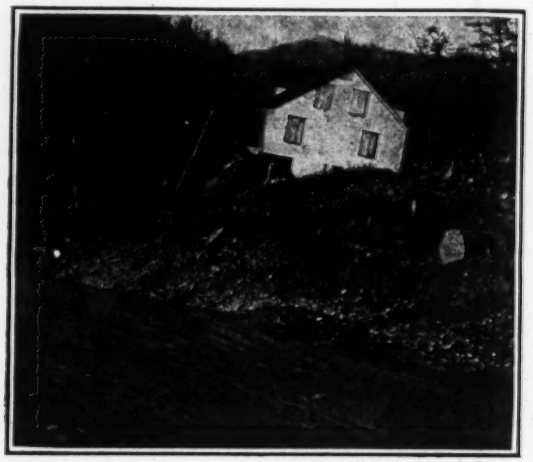
State Highway Developments of 1926 Awarded Blue Ribbon of Distinction by State Highway Engineers

FOURTH ARTICLE

Handling Landslides on Mountain Roads

BY H. J. SPELMAN

Division Engineer, State Road Commission, Huntington, W. Va.



UP-HILL SLIDE TILTS HOUSE

WATER in some form is usually at the bottom of every landslide. This water may cause the slide by lubricating the plane of rock or shale on which the earth lies, or it may cause the slide simply by saturating the earth so that the angle of repose becomes very slight, and the material flows; such a condition is particularly apt to occur in the rainy season. Water may also cause landslides by erosion, or a creek or a river may be flowing against the base of a hill gradually eating it away and causing settlement to take place over the whole mountainside.

Landslides in West Virginia are by no means caused by the road construction itself. Many times they may be seen upon hillsides in cultivated or pasture ground where no construction work of any kind is near. In locating roads care is taken to avoid "slippy" ground, that is, ground presenting the appearance of old slides. It is, of course, not always possible to do this; when a road must be in a narrow valley, already occupied by a railroad track and possibly a coal development, it is oftentimes necessary to locate through a "slide" with the knowledge that the road must be protected against it. Then, too, many roads have been carefully located through ground having no appearance of slides, and yet slides have developed, sometimes during construction and sometimes several years after construction.

WEST VIRGINIA

LANDSLIDES or "slides" or "slips" as they are sometimes called, are met with great frequency in road construction and maintenance in West Virginia. Their cause is in many cases unknown, and at the present time a study is being made by Dr. George E. Ladd of the U. S. Bureau of Public Roads with a view to determining causes as well as means of preventing slides. Landslides are classified in three ways with reference to their effect upon the roadway; those which fill up the roadway, those which heave the roadway, and those which cause the roadway to drop. All of these types have been successfully controlled by various methods. Among the methods successfully used have been the sinking of well casing into underlying solid strata, the driving of wooden piling, the use of sheet piling, the constructing of retaining walls, the construction of drainage ditches, diversion of water courses, the loading of the toe of the slide with rock, as well as the mere method of removal.—C. P. FORTNEY, *chairman, State Highway Commission.*

Types and Extent—Landslides may be grouped into three classes with reference to their effect upon the road:

1. The first class and the easiest to handle is that in which the ground has broken above the grade of the road and has poured down onto the roadbed.

2. The second class is that in which the break has occurred on the upper side of the road but the bottom of the slide is below the grade of the road. In such cases the roadbed is heaved upward from a few inches to several feet and the surface of the pavement is often warped or twisted and sometimes entirely broken, and often in addition, material pours in from above and fills up the roadbed. Such slides occur usually in cuts through the toe of a hill; in some cases, through-cuts have been almost entirely filled up by action of the sliding material.

3. The third class is that in which the roadbed in fill or in cut has fallen due to breakage or movement of the ground below it. This class is usually the most difficult and most expensive to handle. Only a few feet in width of the roadway may fall, or the entire width of the roadway may fall to such an extent that the road cannot be traveled.

A slide may extend only for 30 or 40 ft. along or parallel to the center line of the roadway, or it may be several hundred feet in length. In southern West Virginia, they are usually from 150 to 300 ft. in roadway length each, and they may be several miles apart or they may be at very frequent intervals. On one particular road along the Ohio River, about one mile in length and known as Sliding Hill, slides on the lower side have occurred for two-thirds of the entire length and provision has been made to correct them. This road has been constructed for five years and each year new slides have developed and had to be taken care of.

Just what must be done to protect the roadway and control any particular slide is determined by (1) the character of the slide, (2) its location, (3) the alignment of the road, (4) the depth of the sliding material, and (5) the character of the underlying solid material.

Soundings with bars or in some cases with a calyx drill are taken at every slide, unless it is one which it is apparent will be handled most cheaply by removal or

unless solid rock strata appear on the surface. Where the slide has filled or heaved the roadway (either of the first two classes) these soundings are usually taken about 3 ft. back of the ditch line. Where the slide has caused the roadway to drop (the third class), the distance beyond the roadway edge at which the soundings are taken is determined by the depth the roadway has dropped, the soundings being taken at a point beyond the probable toe of the new fill. In some cases it is desirable to take soundings at varying distances from the center line to determine the slope of the underlying solid material.

Slides from Above the Roadway—Ordinarily, the easiest way to handle a slide which is coming in from above is by removing the material, but this is determined of course by the extent of the slide and an estimate of the amount of material to be moved. Extensive relocation is seldom desirable in such cases, but the material removed from the slide may be used on sidehill locations to widen the section of roadbed in each direction from the slide and thus swing the line of the road farther away from the hillside and the slide. If the slide is of great extent this may have to be done even at some sacrifice to the alignment of the road. A railroad or other right-of-way condition often makes it impossible to do this. If the quantity of material to be moved is great or if the removal of the necessary material would cause the destruction of a valuable house or building on the hillside above the road, it is sometimes necessary to drive piling or sink well casing or construct a retaining wall to hold the slide.

A number of slides from above the road have been

PAVEMENT HEAVED BY LANDSLIDE
Note the piling driven to hold the slide and the steam shovel in the background starting to remove the destroyed pavement.

corrected by digging intercepting ditches above the line of the break on the hillside or by removing a certain amount of the material in dry weather and shaping one or two shallow ditches down the face of the slide into the road ditch, so that all water falling in the slide area is quickly drained into the road ditch. When slides of this character first develop there are usually pockets formed near the break line, and these pockets of course hold water unless the material is removed and the whole surface of the slide shaped as stated so as to drain. By the break line is meant the line which always develops where the sliding material separates from the adjacent solid material. It is very important in such cases to examine the entire hillside so as to find the highest break line, since there may be a number of them, and at each of them pockets holding water usually develop.

Slides Heaving the Roadway—Slides of the second class (that is, those in which the grade of the road is heaved upward) are more difficult to repair or correct. Where it is possible to relocate the road in such cases so as to avoid the slide area, it should be done. On one particular road, located through the base or toe of the hill about nine years ago, the through cut had almost entirely filled up, due to both heaving and flow of

PAVEMENT HEAVED BY LANDSLIDE
Piles driven and pavement since replaced with rock asphalt at the proper grade.

material from above, and it was found desirable about four years ago to relocate the road around the toe of the hill at some sacrifice to the alignment. There has been no trouble at this place since this relocation but the old through cut has almost entirely filled up from above and below. In many cases of this kind, however, the road and its right-of-way have been established, a pavement has been laid and relocation would be more expensive than correcting the slide. In such cases, these slides may be corrected by using either piling or well casing and by underdrainage.

On one federal-aid road, about 200 ft. of reinforced-concrete pavement was heaved up to a height of 3 ft. or more, the pavement broken into bits, and the roadway partly covered from the adjacent hillside. It was found that the ground had broken for several hundred feet up on the slope of the hillside. A double row of piling was driven back of the ditch line to a depth of about 15 to 16 ft. into an underlying stratum of gravel, the piles being 20 ft. in length and being permitted to extend 4 ft. above the ditch elevation. These piles were set 5 ft. on centers and staggered. A view here shows the location after the piling was driven and before the old pavement was removed. After the piles were placed a tile under-drain was placed to a depth of 4 ft. below the ditch grade about 2 to 3 ft. outside the piling, and the underdrain trench was backfilled with gravel, and drained under the road to a nearby creek. The old pavement and slide material were then removed and a new concrete pavement placed. This was in 1922 and there has been no further disturbance of the pavement. A small amount of material works through the piles and the ditch has to be cleaned out perhaps once or twice a year.

In another case, a concrete road had been constructed near the base of a hill. The slide extended up the hillside for about 100 ft. The year after the concrete was placed, an area of about 120 sq.yd. of the pavement was badly warped and out of shape, having risen to a height of 1 ft. at the highest place above the original grade, and the roadway was partly filled with slide

material. Wood piles 20 ft. long were then driven in a single row on 3 ft. centers back of the ditchline. The third view shows the piling and "heaved" pavement before replacement. After the piling was placed the warped pavement was taken out, the subgrade was dug out to its original depth and the concrete fragments were broken by hand to stone base sizes and placed back on the subgrade and tamped thoroughly. A rock asphalt surfacing was then laid. This work has been completed for over two years and no further trouble has been experienced.

In another case on the same concrete road, a very similar slide was encountered, except that rock was shown by the soundings about 7 ft. below the ditch line. At this place a row of well casing was placed, about 3 ft. center to center, extending 7 ft. into the rock, the casing being from 18 to 22 ft. in length. When the casing was being set the water level rose almost to the level of the ditch in the casing, so that it was decided to construct a tile underdrain in the ditch line between the row of well casing and the concrete pavement. The area of pavement warped was about 60 sq.ft. and the greatest height was about 15 in. The view shows the location after the casing had been placed and before the warped pavement had been lowered. Here the material was excavated from under the concrete to the original subgrade elevation, the concrete being supported on large stones and blocks of wood. It was the intention to lower the concrete pavement which was cracked, but not broken, to its original position; when the pavement was lowered it was found that it was about 1 to 1½ in. low, due to the exact subgrade not having been obtained. The surface of the concrete over the area was then brought to grade by a layer of rock asphalt. The rock asphalt surfacing in both these cases was not rolled. It was thoroughly tamped with iron hand tamps and has since rolled out very smooth under traffic. This particular place was repaired over two years ago and no further trouble has been experienced.

Slides Under the Roadway—The third class of landslides (those in which the roadbed has fallen) are usually the most difficult and expensive to replace, and also the most difficult to anticipate. Often such a slide will carry with it a culvert or part of a culvert which breaks into pieces and permits the water to flow through the slide material soaking it up and making the condition much worse.

Where a culvert is broken in the slide area the first task is to take care of this water. Because of the prevalence of mine water, most of the pipe culverts used in West Virginia have been of the rigid type, such as reinforced concrete or vitrified tile encased in concrete. These culverts, of course, open up and break readily under the movement of the slide. The broken pipes are first all removed back to the break line of the slide. A corrugated metal culvert is then placed in the end of the portion of the original culvert on solid ground, and carried to a point of discharge well clear of the slide area. These flexible type culverts have the decided advantage that even under later movement of the slide they are not likely to open up and permit water again to enter the slide area. In some cases it is possible to divert the water entirely away in the road ditch to a new culvert location entirely outside of the slide area, and when this can be done it is done. In such a case it is necesary to remove entirely the old culvert or to seal the opening with a concrete cap and it may also be necessary to pave the road ditch to the new culvert location to keep the water from soaking through the roadbed and getting into the slide area again.

After this drainage provision has been made, the further correction or control of the slide is undertaken. Usually, the cheapest method is to throw the center line back into the mountainside, cutting the roadbed out anew on solid ground. This method can usually, though not always, be used in the construction stage of the road on mountainside locations, where such a shift does not cause serious impairment to the alignment of the road. In such a case, the sliding or broken material is allowed

PAVEMENT HEAVED BY LANDSLIDE

Note the well casing placed to stop the landslide, the regular grade of the tops of the casings is obtained by cutting them with an oxyacetylene torch. The heaved pavement has since been replaced.

to move off down the mountainside. It is also necessary to get the new line well back into the solid material, because this movement of the slide material often drags or pulls with it a portion of the roadbed which seemed perfectly solid after the first break or landslide had occurred.

In case it is not desirable to take care of the slide condition by "throwing" the line back into the mountainside, the slide may be controlled by constructing a concrete or masonry retaining wall on the lower side of the road. Such a method is economical only when the rock ledge is exposed or close to the surface. The rock ledge is benched out and holes drilled in it into which steel dowel pins can be set to project up into the masonry wall. In case the rock ledge does not show up close to the surface, either well casing or piling may be placed to hold the slide. On one project the road had been constructed across and on top of the toe of an old slide, being entirely in fill for about 150 feet. It was thought at the time that movement had stopped. After the pavement had been in place something over a year, it moved out and down and broke up. Wooden piles 20 ft. long, on 3-ft. centers, were driven to refusal, penetrating an underlying shale about 2 ft. A row was placed on each side of the roadway about 20 ft. from the center line, after which the pavement was replaced. The work has been completed for two years and there has been no further movement.

On another project the location was on the hillside of a small narrow ravine, the creek being about 4 ft. in width. During the first winter after the concrete pavement was laid, the roadbed dropped underneath the pavement to a depth of about 3 ft. and extending back under the pavement to a width of 6 ft. In this case the concrete pavement did not fall because it had been reinforced with steel rods. A clay pipe

placed at this point had broken. The pavement was supported immediately at frequent intervals with rock laid up; a corrugated pipe was placed connecting to the solid part of the clay pipe and a heavy rock fill was placed along the toe of the slide in the bottom of the ravine, the creek being cut in a new channel in the opposite hill side of the ravine. The roadbed was then brought back to grade, the fill under the pavement being made to within 6 to 8 in. of the old subgrade elevation with ordinary material and the last 6 to 8 in. being filled with sand thoroughly rammed under the slab. This replacement was made early in 1923 and except for a slight settlement (noticeable to the eye but not yet requiring any patching) no further difficulty has been experienced.

In another case sliding of a fill section developed due

LANDSLIDE BELOW PAVEMENT
Note the temporary support of the slab by stone blocking. Subgrade drops 3 ft. in places.

to the action of water from the adjacent river backing up a small stream at certain seasons of the year. Destruction of a part of the pavement resulted. Steel sheet piling, in lengths of 20 ft. were driven here for 150 ft. along the roadway penetrating about 3 ft. into an underlying shale, and this has effectively stopped the slide.

Where Piling is Used—Piling is used where the sliding material is underlain with a gravel, soft shale, hard clay, or other material into which it may be driven. The piles used have been from 20 to 30 ft. in length as required. They are usually of oak, but may be of other hard woods and are required to be at least 8 in. at the tip. They are used where the underlying solid strata are not considered hard enough or close enough to the surface to permit the use of well casing,

It is desirable to get the piles driven from 18 in. to 3 ft. into the underlying solid strata. They are driven to refusal or until they begin to splinter. Piling in single rows are usually placed 3 ft. center to center; and in double rows they are staggered and placed 4 to 5 ft. center to center. The double rows are used in the slides of greater severity and where the slide area to be held back is of greater extent.

Where Well Casing Is Used—Well casing is used where a hard material is found into which they can be sunk. This underlying material need not be a hard rock. Good results have been obtained with soft sandstones and with hard shales. Each casing is set at least one-third of its entire length into the sandstone or shale. The casings ordinarily set have been 18 to 22 ft. in length, but in a few cases the length has been as great as 36 ft. The casing used is ordinarily second hand, which can be purchased in the oil and gas fields. The sizes are from 6 to 8 in. inside diameter. It is required to be sound throughout and reasonably free from rust.

In placing the casings holes are sunk through the earth covering and into the underlying solid strata of rock or shale to a depth at least equal to one-third the length of the casing. These holes are placed from 3 to 5 ft. center to center, a wider spacing being used for the larger sized casing, ordinarily, and the spacing being varied somewhat depending upon the depth of the sliding material. To drill these holes, ordinary well drilling machines which are rented in the locality have been used. About two years ago, so much work had developed that a machine was purchased for use in the division, and it has been operated continuously ever since.

In placing these holes care should be taken not to get them too close to the edge of a vertical break in the rock ledge if one exists. The holes should be set at least 6 ft. back from the face of the break in the rock ledge in such cases, in order to avoid the breaking off and movement outward of the rock due to the cutting of the holes.

After the holes are drilled to the proper depth the well casings are set in them. Since the casings are not always the same length and since the holes cannot always all be drilled to the same depth, the tops after placing are cut to a uniform grade, for the sake of appearance, with an oxyacetylene torch. The casings are then filled with 1:2:4 concrete, in which are sometimes though not always, placed three ½-in. square reinforcing bars.

In one case a light concrete retaining wall was constructed resting on the ground surface and entirely surrounding the casings. This was done principally for the sake of appearances, the slide having developed on one of the main roads in front of a residence. Usually

ROAD COVERED BY SLIDE FROM ABOVE
Material removed by steam shovels, one working from each end. This slide blocked railway (downhill) for three days and highway for three weeks.

rocks are roughly set up by hand along the line of the casing both in front and behind, after which the earth fill is replaced, if the casing is on the lower or fill side of the road.

In another case, the supply of well casing running short, 2 or 3 old railroad rails were placed in the holes instead. The following spring the rails were bent to an angle of about 15 deg. and they were replaced with well casing.

Costs of Removing Slides—The cost of removing slide material varies with the locality and the condition of the material. When removed on a construction contract it is paid for at the contract price which may range from 45 to 85c. per cubic yard. No records of the cubic yard cost of removing slide material by state maintenance forces are available.

Wood piling in the division has been done entirely by contract, the price ranging from 85c. to $1 per lin.ft. The average job probably will have about 3,000 lin.ft. of piling. The lengths driven have been 20 ft., 25 ft. and in one or two cases, 30 ft.

Well casing work done by contract has ranged in price from $2 to $2.50 per lin.ft. for the reinforced type in four jobs averaging slightly over 1,000 feet in each. This price is based upon the number of feet of pipe used, and includes the concrete filling, the steel rods and all work connected with it. On each of these jobs the work was let as an item in a regular road contract and the price is high both because of the small quantity involved and because of the contractors' unfamiliarity with it.

Well casing work has been done by state forces, both with rented well drilling rigs and with a state owned rig. With the rented rigs the price of this work has ranged on various jobs involving an average of 1,400 lin.ft. per job from $1.55 to $1.86 per foot of casing placed.

In the first year's work with the state owned outfit there has been placed 13,600 ft. of 6-in. casing filled with concrete but not using reinforcing rods at an average cost of 88c. per foot of casing placed. This cost figure does not include the allowance for depreciation on the well drilling machine which, for the quantity involved, will exceed 8c. per foot, making a total cost of 96c. per foot. Casing reinforced with steel rods will probably cost about 15c. more. Costs have been reduced materially with the state-owned outfit over the rented outfit because much greater efficiency is obtainable from the driller and because the charge paid for renting an outfit was much higher than the actual depreciation. The price of the well casing itself which is included in the figures given above will average 35c. per foot.

One steel sheet piling job has been done. The total cost of this was $1.01 per lin.ft. for 4,000 ft. of piling driven. The material was furnished by the state and driven by contract at a contract price of 60c. per foot.

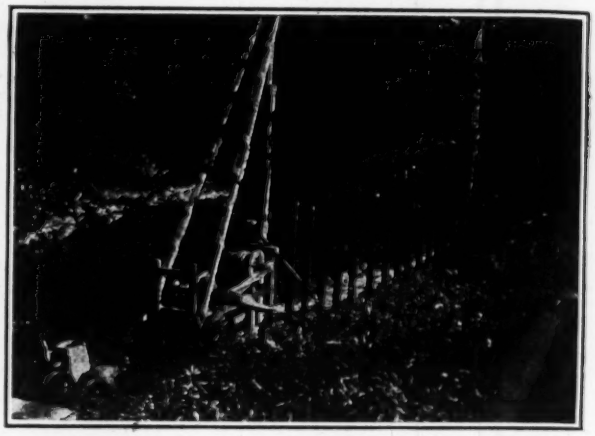
It will be seen from these figures that with the usual spacing of 3 ft. and lengths of 20 ft. the cost of wood piling per lineal foot of landslide ranges from $5.67 to $6.67, that well casing without steel reinforcement will cost (based on 96c. per foot) $6.40, and with steel reinforcement, $7.40 per lin.ft. of landslide. Steel sheet piling on the other hand, cost in the one instance where used $28 per lin.ft. of landslide. These figures, of course, do not include any allowance for removal of slide material or replacing fill, nor do they include any cost of pavement replacement.

Conclusions—Landslides may be successfully controlled in highway construction and maintenance.

1. Soundings should be taken as soon as any landslide develops to determine the depth of sliding material and the character of the underlying solid material. (By solid material is meant the material underneath which is not moving.)

2. Piling can be successfully used in depths of sliding material up to at least 20 ft., on underlying strata of gravel, hard clay or soft shale.

3. Well casing can be successfully used in depths of sliding material up to at least 20 ft. on underlying strata of hard shale, or any sand stone.



WELL DRILL MACHINE SETTING CASING TO HOLD LANDSLIDE

4. Retaining walls are effective but not ordinarily economical for slide control, unless the rock is exposed close to the surface. Such cases usually occur only very close to the toe of the slide.

5. Underdrains are effective in conjunction with piling or well casing in slides of the heavier type and should probably always be used in such cases.

6. Where the slide is below the road surface, drainage must be kept off it at any cost.

7. Where the slide is above the road, surface drainage should be kept off it by intercepting ditches and in addition surface ditches should be constructed on the face of the slide to prevent the formation of water pockets at the "breaks."

Removal is the only method that can be adopted for many landslides, but it should not be used where other methods of control are cheaper, or where it means a considerable sacrifice of alignment.

Steel Frame House Built with Brick Walls

A small dwelling house recently built at Great Neck, N. Y., to designs of John T. Briggs, architect, has brick walls, steel floor and roof framing, reinforced gypsum floor slabs with wood finish floors, gypsum and hollow tile partitions, and slate roofing on waterproofing felt on precast gypsum slab roof. The stairs are of steel, those above the first floor having 1¼-in. oak treads bolted to the steel treads; similarly, the stair balusters are iron bars, carrying a wood hand rail. Door bucks of wood stiffen the partitions and provide attachment for doors and trim. Plaster is applied directly to the partition tile, and in the case of ceilings and exterior walls on metal lath on furring. According to data given by R. S. Tilden in the *American Architect* of February, the total construction cost of this house was 52c. per cubic foot. The house has six rooms, is about 27¼x33½ ft. in size, two stories and basement high with partly finished attic, and has a masonry walled garage in basement. The total volume of the structure is slightly over 30,000 cu.ft.

Conditions and Prospects on the Colorado Delta

Three Articles Giving Different Views on Needed Protection of Lands at the Mouth of the Colorado—Seriousness of Present Situation Emphasized

NO ENGINEERING problem today is more live than the proper protection of the low-lying land that forms the valley of the Colorado River after it leaves the mountains. It is a problem on which there is a diversification of view among those who know most about it. Fairly to represent this diversification *Engineering News-Record* presents herewith three articles gathered by interview and from papers and reports:

1. A statement of the views of the engineers of the Imperial Irrigation District, which controls the delta lands north of the international line.
2. An abstract of a report by R. M. Priest, of the Reclamation Bureau, emphasizing the seriousness of the conditions and the necessity for action.
3. An abstract of a paper by J. C. Allison, who advocates extensive work in Mexican territory.

* * *

1—Imperial Valley Views on the Colorado Delta Situation

First Importance Placed on Levee Protection East of Bee River Channel; Lower Delta Conditions Chiefly Concern Mexican Lands

NUMEROUS and divergent are the opinions as to just what flood-protection work is now most necessary on the Colorado River delta. The differences have been due at least partly to a lack of accurate data as to conditions on the delta in Mexico where an area of some 800 or 900 sq. miles, much of it thickly overgrown, is subject to uncontrolled inundation in flood periods and an ever changing river channel leaves lagoons and swamp areas that are difficult to traverse at any time. With meager information as to delta topography and with different irrigated areas needing flood protection of different sorts, opinions, including those of engineers, have rather naturally aligned themselves into several main groups dominated by two factions, the one taking the viewpoint of the Imperial Irrigation District and the other that of delta land holdings south of the Mexican line.

The marked difference of opinion between these two groups is that the Mexican land interests see urgent need for channels, levees and other flood-protection work in the lower delta region, while Imperial Valley interests believe that the greater danger to their holdings and hence the territory where protection work should now be concentrated, is the upper reaches of the delta, particularly in that stretch of levees lying between mile 8 and mile 24 as measured from the main canal intake.

The point of view of the American interests on the lower delta is outlined in a paper by J. C. Allison, chief engineer for the Colorado River Land Co., an abstract of which is published elsewhere in this issue. The views of the Imperial Irrigation District, as outlined to a representative of *Engineering News-Record* who recently visited the District, reflect quite another angle of the situation. The following notes were accordingly arranged to bring out those elements of the situation to which the District attaches most importance. There is also in this issue an abstract of a report on delta conditions by R. M. Priest, engineer of the Bureau of Reclamation. A comprehensive discussion of flood protection problems on the delta by S. L. Rothery appeared in *Engineering News-Record*, Dec. 31, 1925, p. 1068.

To analyze and compare the several viewpoints necessitates consideration of topographical conditions on the delta and habits of the river when in flood. All lands

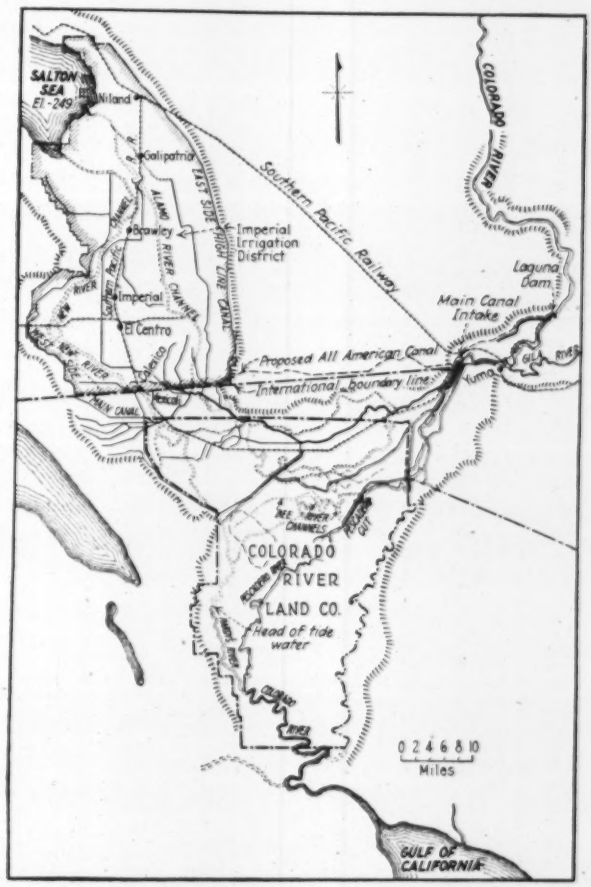


FIG. 1—COLORADO RIVER LAND CO. HOLDINGS AND THE IMPERIAL IRRIGATION DISTRICT

in Imperial Valley and on the delta in Mexico that are irrigated by gravity from the Colorado River have a serious common danger in floods. There is also the menace of complete destruction to a large part of Imperial Valley if a flood were to flow northward into Salton Sea long enough to cut a deep channel back to the main river bed. For American and Mexican lands alike, therefore, Boulder Canyon dam would greatly simplify, even though it would not completely solve, the flood problem. That dam, however, is an ideal to hope for while the problem of flood protection along the lower reaches of the river is a problem of today that must be met effectively until relief in the form of a flood storage reservoir is in more tangible form than a hope.

Curiously enough, the Mexican lands involved, which lie south of the international line and west of the old channel of the Colorado, are largely held by Americans. There is one holding in this area, the Colorado River Land Co., controlled by H. C. Chandler of Los Angeles, which is larger than the entire Imperial Irrigation District. Because of the topography of the delta the flood-protection measures that would best serve these lower lands, particularly those lying between the delta cones formed by the old Bee channel and Pescadero cut, are naturally not the same as the protection work needed for lands belonging to the District.

The Pescadero channel, extending from mile 24¾ to mile 29¾ on the river side (east) of the Pescadero dam and levee, was completed in 1923 and was expected to serve for about 10 years in materially reducing the flood menace in the vicinity of the old Bee channel. Thus far there has been no permanent silting in the Pescadero cut; rather, there has been a recession each year. In other words, the main deposition of silt in recent years has been occurring below the outlet of the Pescadero cut where the waters have spread out on the delta cone. After spreading out, the velocity has decreased so that deposition has occurred.

Because of its very high silt content, the Colorado River requires a slope of 1.2 to 1.5 ft. per mile. This is enough to prevent silt deposition during flood. In low stages of the river the silting up of channels on this gradient does occur but the floods periodically carry out this low-flow silting in the process of deepening the channel to flood capacity.

The Ockerson, Bee and Pescadero levees constitute a continuous first line of defense against overflows of the river. Beginning at the intake of the main canal at Andrade, they extend about 32 miles into Mexican territory. These levees are not high; for the most part they are only 5 or 6 ft. above the adjoining ground levels. This is considered sufficient where the backing is substantial ground not lower than on the river side. The maximum height of levee in the entire 32-mile length (excepting only the Pescadero dam across the Bee channel and other points where cuts have been filled) is possibly 8 or 10 ft. Between this first line of levees and Imperial Valley the land is lower and some distance northward a second line of defense, principally Volcano Lake levee, has long been maintained. The cultivation of the lower land between these two lines of levees is an important factor in the differences of opinion about necessary flood protection.

To the district the most important feature in flood protection is the maintenance of the first line of defense. There are, however, varying degrees in the protection afforded by different parts of this line of levees and a break near the upper end is considered to be much more serious than a break near the lower end because of the probable effect of such breaks on the course of the main stream flow.

Since the very fine silt that has to be used in building levees makes a current of water highly destructive, a break above the Bee levee might direct a strong current against the second line of defense, resulting in serious danger of going through or passing around the eastern end of Volcano Lake levee. A break at the lower end of the levee system on the other hand, such as the one that occurred at mile 31½ on June 12, 1926, is regarded as of comparatively little importance. A break of the latter sort would inundate at least the lower portion of the same area that would be flooded by a break higher up, but because of the topography, the lower break would be much less likely to involve any current against levees constituting the second line of defense. Calm backwater is not nearly so great a danger as water in which there is no current. On the contrary, there is some advantage in having backwater periodically flood the unimproved land between the first and second line of defense because silt deposited by such water raises the ground level and thus increases the protection just that much. Naturally water standing against the second line of defense is not a desirable condition—particularly in the case of Volcano Lake levee, which is in bad condition—but at worst it is only a potential danger until some break occurs that sets up a current.

Under these conditions it is apparent why District engineers were not greatly worried by the 1926 break at mile 31½. It ruined much property on the lower delta holdings, of course, but it opened a channel to the northward only a mile above the end of the levee system beyond which there is no artificial restriction as to direction of flow. Hence this break was not considered to have been a menace to Imperial Valley lands of anything like the same importance as a break higher up that would have thrown a flood current against the second line of defense.

With reference to conditions below Pescadero cut the point of view of the Imperial Irrigation District as expressed by M. J. Dowd, chief engineer, is as follows: "Prior to the construction of the Pescadero cut, the lands lying south of the Saiz and Volcano Lake levees were subject to overflow each season and therefore had never been cultivated. Following construction of the Pescadero cut the Colorado River Land Co. immediately put into cultivation that portion of the area lying between the Saiz and Bee River levees and is now attempting to place in cultivation the land lying south and east of the Volcano Lake levee.

"As the Pescadero basin silts in and the silt cone extends, of course the flood waters will spread to the east and west and in order to protect the lands mentioned it would be necessary to construct a levee some 10 or 12 miles in a southwesterly direction from the end of the Pescadero levee.

"Our recent surveys have shown that the flattest slope to the south from the present end of the Pescadero levee is something over 3 ft. per mile. It is an established fact that the river silts in to a slope of about 1.2 ft. per mile, which is the stabilizing grade. Thus, were we to extend our levee a distance of 10 miles, built up to a height of 7 ft., on a slope of 3 ft. per mile, we would be faced with the necessity of continually raising the levee as the area silted in so that by the time the stabilized grade of 1.2 ft. per mile had been reached the lower end of the levee would be 25 ft. high.

"This shows the fallacy of trying to make an extension of the Pescadero levee at this time. Such an extension could be justified only by the need of protecting lands in Volcano Lake which are not and never have been protected by our levee system. This is not a matter that concerns either the United States government or the Imperial Irrigation District. In other words, the development of the delta lands south and east of the Saiz and Volcano Lake levees at this time is premature and should not have been attempted.

"I am also of the opinion that the proposal to construct a channel to the Gulf is impractical and will not be

feasible until the silt cone has been carried to a point very close to the Gulf. The channel to the Gulf can proceed only as fast as the silt cone extends and the delta silts in."

Generally speaking, elaborate advance preparations for floods other than having adequate levees in good condition are not regarded by the District with favor. The usual methods of protection consist in maintaining at all times a rock-faced levee all along the line where the river is liable to attack and to be prepared to concentrate men and equipment to strengthen any threatened point. The remains of the Ockerson levee stand as an example of extensive work that undertook to accomplish in one move a radical change in the river course. This is now believed to have been more of an undertaking than reasonably effective emergency work in time of danger could be expected to protect. Of the 25-mile length of the original Ockerson levee about 90 per cent was either lost or has had to be largely rebuilt.

Once work is begun on a levee or other obstruction to the flow of the river in its accustomed channels, it must be carried to a safe height and made amply strong at the outset. Any obstruction in the usual channels in the low lying country causes the river, in flood stages, to spread out over a large area, thus forming an extensive reservoir. The resultant increased head on the obstruction and the large volume behind it constitute a menace much greater than that of the stream flow alone; if a weakness does develop so that the obstruction begins to cut away, sweeping destruction may be expected.

Where the river normally flows about 10 ft. deep in low stages it is usual for floods to increase this depth to 30 or 40 ft. The river bottom is ever changing with the stage of flow; when velocity decreases the sediment in suspension settles and fills the lower part of the channel and when the current increases it quickly cuts away again to great depth. Dumping rock as continuously as possible at the toe of a bank that is being cut away is regarded as much more effective than piling up the rock farther back where the entire mass will later be undermined at the brink of a vertical embankment.

Experiments in protecting the levees where the bank is starting to cut have been made with various types of current deflectors. Those which are effective in the more moderate currents of the main canals have been found altogether useless in the greater velocities and depths that obtain in the river. A type of deflector consisting of pyramids of railroad rails weighted with concrete and held together by cables has been very successful on the Colorado in the vicinty of Blythe. This type is yet to be tried on the District's protection works.

The dumping of rock is the accepted method of combating the cutting of the river in flood, and the speedy and continuous delivery of rock at the toe of the slope being cut away is the present method of deflecting dangerous currents. Normally, about 50,000 cu.yd. of rock

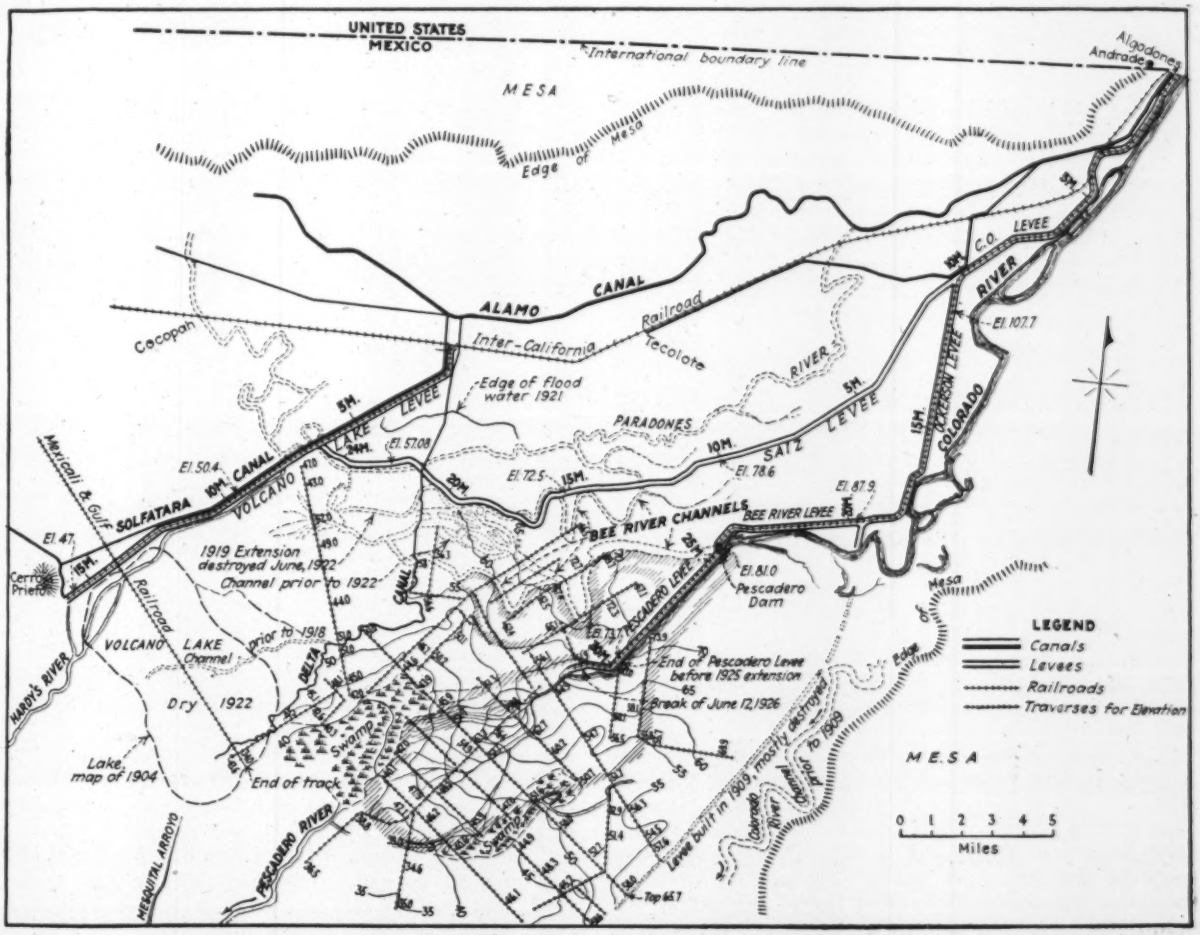


FIG. 2—RELATIVE LOCATIONS OF CHANNELS AND LEVEES ON COLORADO RIVER DELTA

is put on the first line of defense each year, strengthening the weaker sections and checking cutting in its incipient stages where danger threatens. However, the quarry near the intake at the upper end of the levee system is so laid out and the forces are so organized that when emergency arises the rate of delivery is limited only by the capacity of the single-line railroad down the levee system.

The main portion of the typical levee is built of the only material available, i.e., the fine silt of which the entire delta is composed. This is scraped up, usually by draglines, from long borrow pits on the side of the levee away from the river, the cost of this work being about 15c. per cu.yd. delivered. The levee is not considered complete until rock is dumped on the river side; such a rock facing extends for the full length of this first line of defense. For the ordinary low levee the plan is to put on about 2½ cu.yd. of rock per lineal foot of levee. Toward the lower end of the 32-mile haul the cost of this rock increases to about $1.25 per cu.ft.

It is significant to note that borrow pits or other depressions very quickly fill with silt if flood water stands over them for any considerable period. The break in the Pescadero levee extension last year allowed backwater to stand over the borrow pits from which this levee had recently been constructed and these pits for as much as half a mile from the break were filled level-full with silt during the period of three or four weeks in which they were under water.

The rate of deposition and cutting in flood periods is, to those not acquainted with the Colorado, almost unbelievable. Deposition 8 to 10 ft. deep may occur in a single season on overflowed land, and in the stream bed itself the scouring of a rising flood may deepen the channel 20 or 30 ft. in a few hours. Profiles run over the delta below the mouth of the Pescadero cut and continuing in the direction of its center line, as reproduced in the article by Mr. Rothery already referred to, show that successive floods are steadily building up the original ground level at this point. However, in the opinion of District engineers the delta area below the cut offers silt storage capacity for a number of years before there is probability of thereby increasing the present flood menace to lands of Imperial Valley.

Surveys have this winter been made under the direction of the District, which have taken elevations at frequent intervals on traverse lines run at right angles across an area of some 160 sq. miles of the delta near and below the Pescadero cut outlet. These lines traverse the delta from the Ockerson levee on the east to the delta canal on the west and, when the notes now being worked up are completed, are expected to give the most complete picture thus far made of the topographical situation in that region.

The problem of maintaining the levees along the first line of defense will be a factor in the District's program for many years regardless of whether some storage dam is built on the Colorado River. Floods on anything like the order of 200,000 sec.-ft. constitute a very serious menace to Imperial Valley lands, and floods of this size have come from the Gila River which joins the Colorado at Yuma. Flood storage is proposed on that stream also, however, and in time it is believed that storage measures will remove the present continual anxiety. Meantime the feeling in the District is that the limited funds it has will best improve the security of Valley lands against floods if expended in the upper portions of the levee system where the consequences of breaks would be most serious.

M. J. Dowd is chief engineer of the Imperial Irrigation District and F. E. Higley is superintendent in charge of operations at the quarry and maintenance of the levees.

* * *

2—Channel and Levee Conditions in the Colorado Delta

Reclamation Engineer Reports on Last Year's Levee Break and Present Danger—Situation Is Considered Serious

PRESENT conditions in the Colorado River course through the delta region south of the international line are described in a report recently rendered by R. M. Priest, engineer with the Bureau of Reclamation. From a copy of this report made available by courtesy of Dr. Elwood Mead, Commissioner of Reclamation, four airplane views are reproduced herewith to show important features of the physical situation.

Since 1922 the southward diversion of the Colorado River from the Bee River channel through the Pescadero cut has operated. Its effect is exhibited most generally by the photographs Figs. 1 and 2.

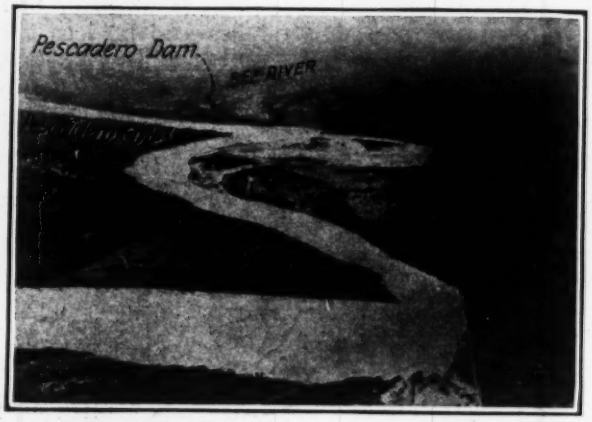


FIG. 1—LOWER COLORADO RIVER: BEE RIVER SECTION AND PESCADERO CUT, LOOKING WEST
At right, levee exposed at miles 21½ and 23.

Fig. 1 shows several miles of the river directly above the head of the Pescadero cut, and reveals that the river is meandering actively and has attacked the north bank levee at two points. The first point, in the foreground, is at mile 21½ (measured along the Imperial Irrigation District levee), where the river makes a sharp bend and impinges directly on the levee. The 1925 and 1926 summer floods attacked this point severely, and it was held only by heroic effort, although these floods were comparatively moderate. In the flood of 1926 there was 4½ ft. of freeboard with only about 67,000 sec.-ft. flowing. Floods of 130,000 to 150,000 sec.-ft. are not uncommon, and surges of 1½ to 2 ft. often occur at intervals of a few minutes. Under such conditions the exposed levee would be in serious danger of breaching. Similarly, at the Pescadero dam (farther back in Fig. 1) there was only 5 ft. freeboard last summer, and with a doubling of the river volume the levee might easily be topped or else become so saturated that trains could not operate on it, preventing protective work by stone revetting here or on the river's lower course.

FIG. 2—LOOKING NORTHEAST ALONG PESCADERO CUT
Pescadero dam and Bee River in distance.

Just above the Pescadero dam, at mile 23, a section of levee on the right or north bank of the Bee River was cut away last year on the receding flood. If this had happened at full flood the river would probably have bypassed the Pescadero dam and gone back to the old Bee River channel, threatening the Volcano Lake levee. Fortunately, the river had already fallen part way, and a levee and railroad could be built around the break.

"Without further protection work," Mr. Priest states, "it is probable that the river will again find its way into the old Bee River channel through or around the ends of the present levee. During the past summer's flood a small quantity found its way into the Bee River channel and started cutting back to the main stream. This evidently occurred at or about the peak of the flood, for recession had taken place only a short time."

Conditions south or downstream of the Pescadero dam are exhibited by Fig. 2, which is a view looking northeastward from a point 15 miles or more below the diversion. The old course of the river, along the Bee River channel, may be seen in the left background. Downstream of the Pescadero dam, which diverted the river from this channel, the present channel consists of four miles of dragline cut and about six miles more of channel, most of the latter being formed in delta fill, although the river also has dug somewhat into the natural ground, which is heavy and does not cut readily. Below the point where the river has formed a definite channel, it scatters into many small channels and is continuing building the region up with silt.

Along this lower course of the river, a levee was built last spring on the west bank from the lower end of the Pescadero cut levee at mile 29¾ for about 2½ miles, by the Imperial Irrigation District in co-operation with Mexican land interests; below this, some two miles more was built by private interests. This part of the river is shown more in detail by Fig. 3, which brings out clearly how the river scatters beyond about mile 34, and how the levee along the west side was breached at mile 31½ during the 1926 flood (at 67,000 sec.-ft.). This breach developed through undermining at a time when the levee was saturated by water standing within two feet of the top. The levee had been built about 7 ft. above ground level; the outflowing water deposited about 4 ft. of soil at the break. Later in the year, on Oct. 2, a flash flood of 36,000 sec.-ft. volume went through this break nearly at the height of the summer flood, and breached the levee lower down at several points. Most of the latter levee had been built ahead of the formation of the delta cone (the ends of this cone are indicated by curved growth lines in Fig. 3, at the point where the river abruptly opens out).

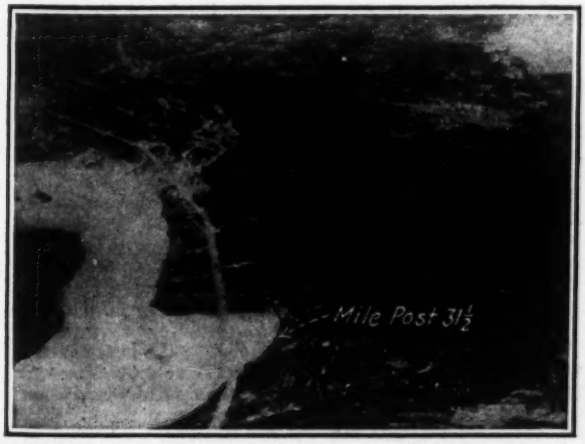


FIG. 3—BELOW PESCADERO CUT, LOOKING SOUTH
Levee breaks at miles 31½ and 33; beyond, water scattering with no defined channel.

The lower Colorado is now wandering around through the brush in small channels endeavoring to find or make a channel, with no definite tendency at present. Comparing conditions now with those seen on an inspection trip in 1922, Mr. Priest concludes that the delta cone has been carried forward four to five miles in the last four years, apparently with increasing tendency toward the west. Formation of a channel by the building up of bank deposits on top of the natural ground is going on, but the trend of direction of this channel cannot be foretold. The floor plane, which dropped for several years after the opening of the Pescadero cut, now seems to be rising, maintaining the average slope of the river of 1.2 ft. per mile, which is flatter than the slope of the land below the end of the present definite channel. If the river continues to move westward toward the West Mesa it will in a few years build up a cone across the low ground from which it may break northward and become a serious problem. He therefore believes that efforts should now be made to lead the river southward, away from the low ground and old channels that lie to north and west. Unfortunately, building levees in this vicinity ahead of the delta cone is considered hazardous and the levee would be difficult to maintain. Failure would cause the river to be diverted permanently westward toward Volcano Lake.

A branch railroad has been built from the Calexico-Yuma line to and across Volcano Lake, about 30 miles. This may prove an added element of danger in case floods reach Volcano Lake, by raising the water level against Volcano Lake levee, which is a dike about 60 ft. high, 14 ft. wide on top, built for a considerable distance on marsh. The latter levee had to stand one of the highest known summer floods, 190,000 sec.-ft. in 1921, and was only barely held. Its failure might lead to very serious menace to Imperial Valley, if the flow through the breach should concentrate in New River channel, which would create a condition difficult to control. The railroad on the levee has been removed, so that maintenance of this levee in emergency would be difficult. As the Colorado may find its way back to the old Bee River channel, the Volcano Lake levee as the last line of defense should be maintained in substantial and defensible condition.

EDITOR'S NOTE—The preceding outline of river conditions is further illuminated by an official telegraphic

report dated March 8, by P. J. Preston, Superintendent of the Yuma Reclamation Project, describing what protective measures are immediately necessary in the delta. It says, in substance:

The following work should be done on Imperial levees within the next 75 days: Raise lower eleven miles of present Pescadero and Bee River levees sufficiently to assure 5 ft. freeboard during high water. Close all low openings on south cone of old Bee River from Pescadero dam to Delta Canal, to keep backwater from getting into Bee River. Volcano Lake levee should be properly conditioned as a secondary line of defense. Imperial District is now raising last 1¾ miles of the Pescadero levee and is also widening and raising the section of Bee River levee between Miles 21 and 22.

Other information, from Imperial Irrigation District sources, is to the effect that during the last month the District has done work at a cost of about $100,000 on the levee and channel just above Pescadero dam, in preparation for the coming flood season.

* * *

3—Colorado Delta Silting Causes Serious Flood Menace

Land Company Engineer Warns of Disaster That Can Be Averted Only by Means of Prompt Levee and Channel Work

IN DECEMBER, J. C. Allison, for some years chief engineer of the private company that preceded the Imperial Valley Irrigation District and long in close touch with flood and irrigation problems along the lower Colorado River, read a paper before the Los Angeles Section, American Society of Civil Engineers, in which he placed great stress on the present menace to Imperial Valley arising from the silting up of the entire delta area through which the Colorado has heretofore found outlet channels to the Gulf. His chief statements are:

Water of the Colorado River, when conserved and intelligently applied, will adequately supply all irrigation projects in the lower basin. The irrigable areas that will ultimately be served in this way are:

	Approximate Area, Acres
Imperial Valley, Mexico (on both sides of Colorado River)	740,000
Imperial Valley, United States, within the present Irrigation District	448,893
Imperial Valley, outside lands, east and west mesas	323,000
Coachella Valley and Dos Palmos	100,000
Yuma project	100,000
Palo Verde project, including Cibola Valley	65,000
Above Palo Verde Valley, including Parker project	90,000
Total	1,866,893

There are a few high-level areas of doubtful practicability that might be added to this total to bring the area up to 2,000,000 acres. As against this estimate, Arthur P. Davis estimates the total irrigable area at 2,020,000 acres, E. C. La Rue puts the figure at 3,304,000, and J. B. Lippincott makes it at 1,515,000 acres.

The duty of water in Imperial Valley for 1919 to 1925 inclusive is given in the following table, a 10 per cent allowance being made for loss in transit through canals of the Mexican lands where wholesale measurement is made:

Year	Acreage Irrigated in Imperial Valley, United States and Mexico	Volume of Water in Acre-Ft. Actually Used on Lands	Water Duty in Acre-Ft.
1919	553,560	1,697,336	3.07
1920	607,000	1,792,484	2.95
1921	536,000	1,316,205	2.46
1922	565,000	1,474,999	2.61
1923	530,000	1,534,422	2.89
1924	544,000	1,603,000	2.94
1925	586,000	1,706,000	2.93

The average duty of water as taken from this table would be 2.94 acre-ft. per annum. It is to be noted that for five years the average was 2.79 acre-ft. and that in figuring the total quantity required for a large area the amount per acre would be somewhat reduced by the fact that some of the improved area always lies idle. For comparison with other authorities, however, the water duty is actually 2.94 plus 10 per cent or 3.23 acre-ft. The corresponding figures as estimated by Davis, La Rue and Lippincott for the Imperial project are respectively 4.4, 4.5 and 4.5 acre-ft.

The generally accepted average runoff of the Colorado River at Yuma is 16,000,000 acre-ft. per annum. Conserving this water by storage dams would afford between 7,000,000 and 9,000,000 acre-ft. per annum available for irrigation in the lower basin after stream and reservoir losses and municipal diversions amounting to 1,500 sec.-ft. have been deducted and after the upper basins were supplied with water for all practical uses. The average of 8,000,000 acre-ft. would supply 3.23 acre-ft. to 2,475,000 acres, which is half a million acres more than will ever be irrigated in the delta region on both sides of the international line.

Ten years ago it was agreed that only a limited time could elapse before the delta region south of Imperial Valley would silt up to such elevations that levee defensive works on the lower river would be extremely difficult and expensive to maintain. Yet after this lapse of time no storage work is under way. There are no remaining channels in the delta of capacity and extent sufficient to carry off flood waters to the Gulf. In closing previous breaks there have always been available channels into which to divert the stream. These channels are now silted to elevations higher than the surrounding country and the only low-lying ground is north of Volcano Lake levee into the New River basin and thence to Salton Sea. If the river breaks into this last remaining low territory and the New River gorge cuts its way back into the Volcano flood territory, a stoppage of the break would be hardly possible, as the hydrostatic heads would be too great for ordinary dam construction of the character employed in stopping Colorado River breaks.

Recent examinations of the delta region show: (1) The entire flow of the river is now passing from the end of Pescadero cut to the Gulf through innumerable ground surface channels obstructed by heavy growths of brush and driftwood deposits. (2) The deltaic cones are projecting themselves rapidly to the mountains on the southwest and are rising at the rate of 5 to 8 ft. with each flood. (3) The flood plane elevation of the last flood, of approximately 70,000 sec.-ft., is about 16 ft. higher than the bottom of the empty Bee River channel at a point three miles distant.

Volcano Lake levee to the north of this area will not be able to withstand the flood level that will result from this barrier to the river in its path to the Gulf and thus floods will pass over or through the levee to New River and thence to Salton Sea.

The only remedy that can save Imperial Valley is about as follows: (1) Immediately close the present break in the levee and build a temporary levee somewhere along the present northerly stream line; (2) systematically raise and strengthen the levees above Pescadero dam, providing continuously for ample freeboard above the rising flood plane; and (3) commence the construction of a channel on as straight a tangent as possible, connecting the river mouth at the Gulf with the present channel of the river near the Arizona south line. This channel should be located as close to the Sonora Mesa as possible and the work should be done with hydraulic dredges to enable the construction of flat sloped, well puddled levees on each side of the channel.

On the westerly levee a railroad, well revetted, should be built to grades sufficiently high to retain flood water through the cut. There should be at least three cuts spaced sufficiently far apart to accommodate the flood discharge of the river when they are joined together by cutting action along their banks. If these cuts are made through to the Gulf, a diversion of the river flow into them will be accomplished without any difficulty whatever; and once in these cuts, the flow can be maintained within a channel that will be below the surface of the ground except at the lower end.

The work involved is of such magnitude that it can be accomplished only through federal agencies. An emergency appropriation by Congress is absolutely essential to immediately commence the work of closing the break in the levee and raising and extending it before next spring's floods. Only prompt action in strengthening levees will insure Imperial Valley of reasonable security through the next flood season, and meantime extensive investigations should be carried on to determine upon a major plan of channel construction to provide relief from the flood menace until the completion of a storage dam in the upper canyon.

Density of Concrete and the Water-Cement Ratio

Showing That Cement Paste Governs Concrete Density and Density Is Function of Water Content

By F. R. McMillan
Director of Research, Portland Cement Association, Chicago

A paper presented to the Western Society of Engineers, Dec. 6, 1926.

IT HAS often been remarked that in the discussions of the design of concrete mixtures too much attention has been paid to the strength and too little to density and durability. It is the purpose of this paper to present a brief discussion of these questions and to show how they are inter-related to the strength and water-cement ratio.

In this discussion the word "density" will first be used in the usual significance and later modified to more truly

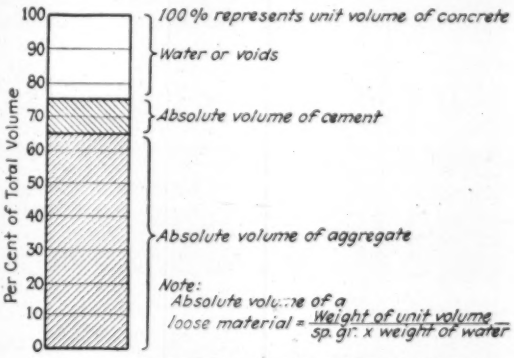


FIG. 1—GRAPHICAL REPRESENTATION OF CONCRETE CONTENT

represent the quality which is generally understood by the term. The usual meaning of density as applied to concrete mixtures is the proportion of the solid matter to the total volume of concrete. That is, it is the sum of the absolute volumes of the aggregate and the cement in the unit volume of concrete. The complement of this is sometimes referred to as the voids. This definition of density is easily comprehended from Fig. 1.

The problems involved in the study of concrete mixtures, particularly with reference to density, can be greatly clarified by a conception of concrete as an aggregate mass thoroughly incorporated in a cement paste. This conception can be visualized from Fig. 1, assuming for this purpose that a unit volume of freshly mixed concrete is represented. The space not occupied by the aggregate is occupied by the paste. Now if the mixture is plastic, that is, not granular, the space not occupied by aggregates must be completely filled with the paste. Under this condition there are no air voids, except possibly some small air bubbles here and there entrained in the sticky paste, and the aggregate particles are completely floated in the paste. That this is true can be shown by a comparison of the measured volume of concrete produced from a given mix with the volume obtained by adding together the absolute volumes of the aggregate, cement and water. This has been done for many mixes and the two volumes found to agree, showing that no considerable amount of air is entrained.

Quantities of Materials—The conception of concrete symbolized in Fig. 1, shows that so long as the concrete is plastic the total volume produced is equal to the sum of the absolute volumes of the aggregate, cement and water. This suggests a method of computing the quantity of cement and aggregates required for a unit volume of concrete. By this method it is only necessary to compute the absolute volumes of the several materials and their total, from which the respective amounts of each material required for a unit volume of concrete can readily be obtained.

For a given volume of a granular material, the absolute volume is equal to its weight divided by the product of its specific gravity and the weight of a similar volume of water.

A method of estimating the quantities of materials differing somewhat in detail of application but based on this same principle is given by Stanton Walker in an article in the *National Sand and Gravel Bulletin* for September, 1926. The feature of interest in this article is the comparison of the measured and computed values of the amount of cement required in concrete for a large number of mixes reported in various bulletins of the Structural Materials Research Laboratory and the University of Illinois. The two sets of values are in almost perfect agreement for all plastic mixes, showing, as pointed out above, that in these mixes the air voids are insignificant.

Concrete Determined by Paste—Under the conception of concrete as an aggregate mass thoroughly incorporated in a cement paste it is possible to explain many of the experimental facts which otherwise are not so easily visualized.

The water-cement ratio strength relation is now so thoroughly established and widely recognized that it can be accepted as a law for the purpose of this discussion. This law is best stated as follows: For given materials and conditions of manipulation the strength of concrete is determined solely by the proportion of the quantity of mixing water to the quantity of cement, provided that the mixes are plastic and workable and the aggregates clean and structurally sound.

In the light of this law the strength of the concrete is seen to be determined by the amount of water in the paste.

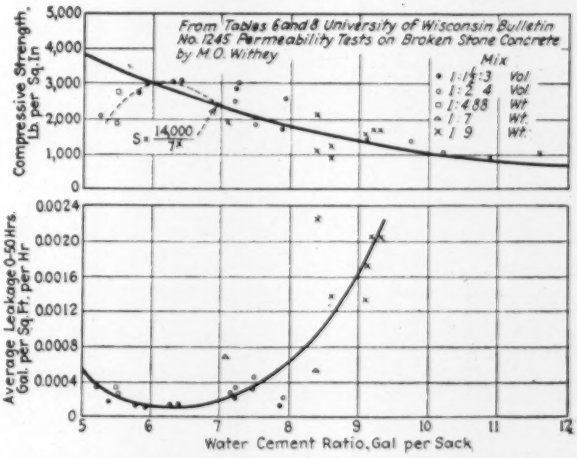

From Tables 6 and 8 University of Wisconsin Bulletin No. 1245 Permeability Tests on Broken Stone Concrete by M. O. Withey
Compressive Strength, Lb. per Sq. In.
Mix
1:1½:3 Vol
1:2:4 Vol
1:4.88 Wt
1:7 Wt
1:9 Wt
S = 14,000 / f
Average Leakage 0-50 Hrs. Gal. per Sq. Ft. per Hr.
Water Cement Ratio, Gal per Sack

FIG. 2—RELATION BETWEEN PERMEABILITY AND QUANTITY OF MIXING WATER

The use of more or less aggregate or of aggregates of different gradings only affects the plasticity or workability and the economy. Increased plasticity can be obtained either by the use of more paste, which adds to the cost, or by a paste of larger water content, which reduces the strength.

The data covering permeability of concrete are very meager in comparison with those showing the strength in compression. Such data as are available, however, clearly indicate that the watertightness is directly affected by the quantity of mixing water. The best data available on the permeability of concrete are the results of tests by Prof. M. O. Withey at the University of Wisconsin. These are published in Bulletin No. 1245, "Permeability Tests on Broken Stone Concrete," 1923. Among the conclusions drawn by Professor Withey from these tests relating to the production of watertight concrete is this principle: Mixes should be of a plastic consistency, of a fair degree of richness, carefully placed and thoroughly cured. Showing the relation between impermeability and compressive strength, he states that: "For properly placed and cured broken stone or gravel concrete the permeability decreased as the compressive strength increased until the latter reached 2,500 lb. per sq.in. Concretes of this strength were watertight."

Fig. 2 has been prepared from the data in Tables 6 and 8 of Professor Withey's report. While the data are not treated in the bulletin with respect to water-cement ratio, sufficient information is given for the preparation of this

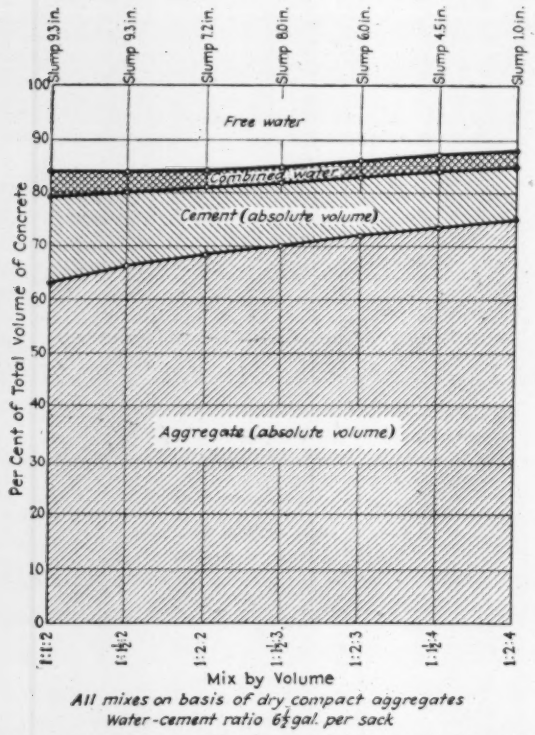


FIG. 3—DENSITY OF CONCRETE OF CONSTANT WATER-CEMENT RATIO

figure. In the lower diagram of Fig. 2 is plotted the relation between average leakage for a 50-hour period under pressure of 40 lb. per sq.in. and the water-cement ratio, expressed in gallons per sack of cement. In the upper figure the compressive strengths are shown for the same mixes.

In the diagram for compressive strengths the curve is that given by Prof. Duff A. Abrams in many if his publications as representing the average relation between the compressive strength of concrete at 28 days and the water-cement ratio. In the equation shown, the water-cement ratio x (an exponent) is the volumetric ratio, a water ratio of 1 corresponding to 7⅓ gal. or 1 cu.ft. of water per sack of cement. At the left of the diagram a dotted curve departing from Abrams' curve is drawn to represent more accurately Withey's tests. This shows a falling off of strength as the water-cement ratio is reduced. This is because Withey used fixed mixes of three consistencies—dry, medium and wet—and it is the dry mixes in each case that show the falling off in strengths. This is in complete accord with Abrams' tests, for he has repeatedly called attention to the fact that it is only the plastic mixes that follow the water-cement ratio strength law.

The curve representing the relation between leakage and water-cement ratio rises somewhat to the left, showing an increase in leakage with the dryer mixes. This is in accordance with Professor Withey's conclusion that only the plastic mixes were watertight. These tests, it should be remembered, were not planned as a study of the water-cement ratio, but as a study of the usual arbitrary mixes of varying consistency. When the data are studied, however, it is clearly apparent that the most important element is the quantity of water used with each sack of cement.

Reverting to Fig. 1, it can be seen how it explains the permeability tests. Any water finding its way through the concrete mass must do so through the cement paste separating the aggregate particles (assuming impervious aggregates). The permeability of this paste is directly affected by the amount of water used, for any water not actually combined with the cement through hydration must later escape as free water, leaving open pores to provide passage of the water under test.

Curing and Density—In taking into account the effect of curing on the density of concrete, it is necessary to redefine the term "density." In Fig. 3 are shown a number of concrete mixtures with constant water-cement ratio, plotted in the same manner as in Fig. 1, with the exception of an additional area to indicate the amount of water which enters into combination with the cement. Since the water actually enters into the permanent internal structure of the concrete it is evident that it should be included with the solid matter in determining the density.

The amount of water which will be taken up in hydration is a function of the period and conditions of curing. It may vary from a very small amount in specimens cured for only a few hours to perhaps 40 or 50 per cent of the absolute volumes of the cement for long continued favorable curing. The amount of this combined water is determined by oven drying, at boiling temperatures, a sample of known weight and composition. Water not driven off is taken as the combined water. This should not be confused with the amount held in suspension when subjected only to air drying at ordinary temperatures.

The importance of including this combined water as part of the solid matter can be seen at once, for the void spaces in the hardened concrete which determine the porosity or permeability are only those occupied by the free water. This meaning of density gives a new significance to the matter of curing and further emphasizes the thought that both the strength and impermeability of concrete are determined by the character and quality of the cement paste surrounding the aggregates.

Grading and Mix and Density—A study of Fig. 3 shows graphically what has long been noted by students of the problem of concrete mixtures, that the grading of the aggregates does not have such an important effect on density as might be expected. Compare, for exmaple, the densities of the 1:2: 2 and the 1: 1½: 4, which range in grading from an oversanded to a harsh combination. The difference of 2 per cent is a very minor matter when thought of in connection with the total voids, as illustrated by the unshaded area.

The mixes in Fig. 3 are for a constant water-cement ratio and the proportion of free water to paste is the same for all mixes. Thus, the only difference in water resisting value of these different mixes is in the respective amounts of paste. For the two extremes in the diagram these are 36 and 25 per cent of the total volume and the passage of water would be approximately in the direct ratio of these respective percentages.

In Fig. 4 two mixes are plotted in a manner similar to Fig. 3. Each mix is carried through several water-cement ratios. In these, it will be observed, the amount of paste does not vary much with the different water-cement ratios, but the character of paste, as indicated by the relative proportion of free water, varies materially.

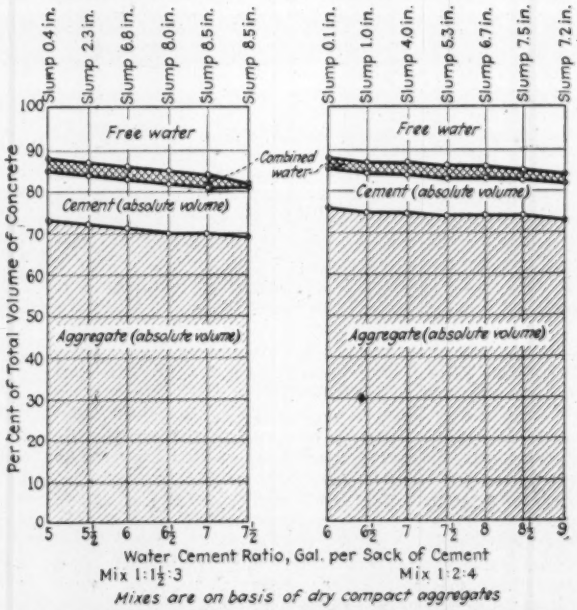


FIG. 4—DENSITY OF CONCRETE OF VARIABLE WATER-CEMENT RATIO

In Figs. 3 and 4 the differences of workability should not be overlooked. In Fig. 3, with a constant water-cement ratio and varying mix, and in Fig. 4, with constant mixes and varying water-cement ratio, the slump varied from 0.1 to 9.3 inches. Naturally these are not all equally placeable. In Fig. 5 are given a number of mixes with about the same consistency, slump 2.8 to 4.5.

In this figure it is seen that for a given consistency little is gained, so far as density in the usual sense is concerned, by the use of one mix or water-cement ratio over another. That is, all of these mixes have about the same amount of solid matter in a unit volume of concrete. In those with the low water-cement ratio, that is, the rich mixes, the proportion of free water to the volume of paste is very much less than for those with a high water ratio, that is, the lean mixes. For example, for a mix having 5 gal. of water per sack of cement the ratio of free water to paste is about 39 per cent, while for a mix with an 8 gal. water ratio it is about 64 per cent. These figures are based on the assumption of combined water equal to about one-third the volume of the cement.

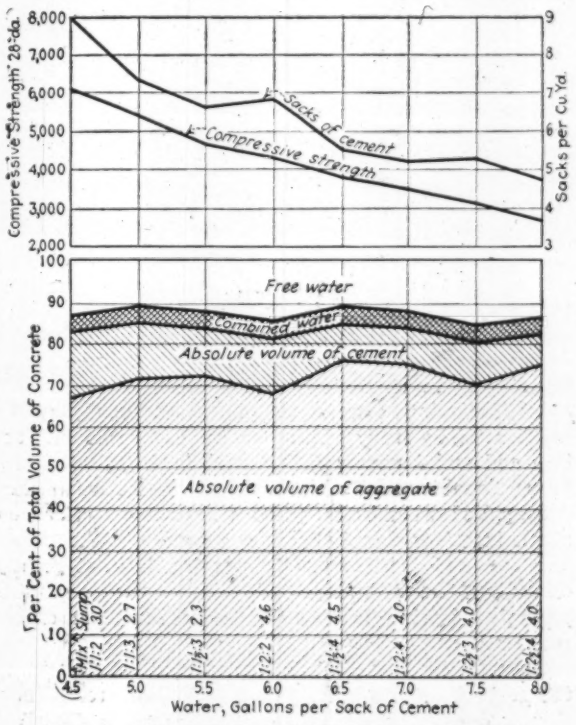


FIG. 5—DENSITY OF CONCRETE OF CONSTANT CONSISTENCY

This difference in the porosity of the paste just cited in Fig. 5 shows the advantage of a low water-cement ratio in the production of impermeable concrete.

Summary—These points relating to concrete placed in a plastic condition and free from honeycomb may be summarized.

Density of concrete should be defined as the proportion of solid matter in a unit volume of hardened concrete. In computing the amount of solid matter, the quantity of water actually entering into combination with the cement should be added to the absolute volumes of the cement and aggregate.

The density of concrete is not of itself a criterion of its watertightness. Since for the ordinary (nearly impervious) aggregates the passage of water through the concrete must be through the space occupied by the paste, it follows that the imperviousness, rather than the quantity, of the paste is the determining factor.

The imperviousness of the paste is determined by the amount of free or uncombined water.

The amount of uncombined water is a function of both the water-cement ratio used in mixing and the extent of the curing.

These considerations lead to the conclusion that concrete to be watertight must be placed in a plastic condition, must have a low water-cement ratio and must be thoroughly cured. This conclusion is supported by all the facts of experiment and experience.

Proposed Aerial Cableway to Summit of Mt. Hood

APPLICATION has been made to the United States Forest Service for a permit to construct an aerial cableway to the summit of Mt. Hood, El. 11,200 ft., near Portland, Ore. The project is reported to be financed to the extent of $500,000, according to the official publication of the Mazamas, a mountaineering organization of Oregon, from which the following notes have been taken.

The company has been formed by L. L. Tyler, experienced in the construction and operation of aerial cableways in logging operations. The cost of construction is estimated at $325,000 to $350,000 including terminal structures and the 2¾-mile railway leading from an automobile road to the foot of the aerial cableway. The proposed round-trip fare to the summit would be $10.

The plan includes an automobile parking area for about 1,000 cars near the terminus of the automobile road that now extends to Cloud Cap Inn at El. 5,800 on the north side of the mountain. From this lower terminus a cable railroad would be constructed to the top of Cooper Spur, El. 5,800, a distance of 2¾ miles. Motor cars on this railroad would be equipped with gasoline engines, each engine operating two drums. Two cables, either one sufficient to carry the load, are to lie on the track, being fastened firmly at top end and tensioned at the lower end. One of these cables is to pass around each drum. The drum arrangement is such that equal tension can be maintained in both cables by a differential device. The grades on this line would range up to 50 per cent.

A 20x40-ft. waiting room would be built on Cooper Spur where passengers would transfer from the railway cars to the aerial car in which the remainder of the trip would be made. Unlike any other mountain in the Northwest, the profile from Cooper Spur to the summit is concave so that it is possible to erect a cable here that would make a clear span of 6,200 ft. from a 50-ft. tower on Cooper Spur to a 100-ft. tower on the summit of the mountain, 2,725 ft. above. This, it is claimed, would be the longest span of any aerial conveyor in the world, being much longer than any in use in the Alps. The contour of the mountain is such that it is estimated the car would be little more than 50 ft. from the face of the slope at any time.

Five cables would be strung over this span, a main cable of high tensile strength steel, 2¼ in. in diameter, and two 1½-in. hauling cables. The cable arrangement is such that there is the equivalent of 5 track cables and in case of failure of any three cables the load could still be transported safely. In both track and hauling cables the tension is automatically adjusted by a counterbalance on an inclined track. The railroad will have a capacity of 120 passengers per hour and the aerial cableway 60 passengers per hour. Power for cableway operation is furnished by engines housed in a small building on Cooper Spur.

The terminal on top of the mountain is to consist of a one-story building, 40x40 ft. in plan with a small observatory on top.

American Railway Engineering Association Meeting

Grade Reduction and Electrification—Track Construction—Concrete Specifications and Waterproofing Bridges—Uniformity Needed in Road Crossing Protection—Grades for Gravity Switching

IN THE numerous subjects dealt with as recommendations or information in the twenty-five committee reports submitted at the annual meeting of the American Railway Engineering Association at Chicago, there was a notable tendency to present economic as well as practical aspects. Thus in addition to specific reports on the economics of railway location, operation and labor, other committees included notes on the economics of ballast supply, the spacing of water stations and the use of treated timber for structures. The majority of the subjects related to railway track, either as to materials, construction or maintenance. Specifications were adopted for the waterproofing of solid-floor bridges, and for plain and reinforced concrete, the latter being a revision of previous matter. As usual, there was extended discussion on only a few subjects, but this was due to lack of will rather than lack of time, since most of the sessions ended well within the allotted time.

Track Structure

Ballast and Ties—In a review of various plans and experiments with permanent roadbed construction, including the recent ½-mile of concrete roadbed on the Pere Marquette R.R., the committee on Roadway discounted some of the claims made and summed up the advantages as follows: "A practical certainty of reduced train resistance of great value, a certain advertising value, a certainty of less dust, and a chance of reduction in maintenance costs of both roadway and equipment." In discussion, Mr. Cushing (Pennsylvania R.R.) expressed strong doubt as to the value of track structure with rails laid on concrete, since the concrete itself is on a yielding surface, while rails are likely to be battered between the wheels and concrete.

Specifications for washed gravel by the committee on Ballast, as adopted, provide that not more than 2 per cent of the sample should be retained on the 1½-in. screen and 3 per cent on the No. 10 screen. While the committee doubted the value of comparative tests on different kinds of stone ballast, on the ground that length of haul usually limits choice of material, several members considered it wise to haul good material for a long distance rather than to use inferior local stone, especially in view of the increasing wheel loads. The matters of quality of stone, shrinkage of ballast and remedy of pumping joints were referred back for further consideration.

Ties, Rails and Frogs—Increased use of the A.R.E.A. specifications was noted by the committee on Ties. Some railways still accept undersize and unsound material, but the committee says it is "incomprehensible why such reckless inspection persists." As the practice of boring holes for cut and screw spikes is increasing, the committee recommended further tests as to the most effective size of hole in offering resistance to both vertical and horizontal pressure on the spike. For the support of track crossings, different arrangements of ties and timbers were approved, as submitted by the committee on Track. Its proposed design of a foundation for such crossings, composed of precast concrete slabs under the ballast, was endorsed by O. F. Harting on the basis of experience with such construction on the Terminal Railroad of St. Louis. Detail plans for frogs, switches and track crossings, as approved, included the flange or self-guarded type of frog, which dispenses with guard rails. Investigation by this committee shows that there is no uniform basis of practice in curve elevation. Present conditions are evidently about the same as when the subject was discussed in *Engineering News-Record* of March 16 and 23, 1922.

Rail failures, as recorded by the committee on Rail, show a slight increase for 1925, but this is attributed to lack of uniformity in reports, and it is believed that the general downward tendency will continue. Transverse fissure failures are occurring at the rate of nearly 4,000 per year and high rates of failure are not confined to rails and heavy traffic. A number of devices for detecting these fissures were described. The application of gas-welded bonds to the outside of the rail was approved as good practice. A study of the battering of rail ends at joints, indicating among other things that mitered or angular joints are of no benefit, presented the following conclusions (approved also by the committee on Track) which were adopted: (1) Joint battering cannot be prevented, but may be ameliorated by study of mill conditions, track construction and maintenance; (2) battering is approximately proportional to width of joint gap; (3) effective anchorage applied when rail is laid (in both directions on single track) is essential for preservation of the expansion spaces; (4) adequate bolt tension, but not greatly exceeding that required to produce the maximum strength of joint, is essential for maintenance of expansion spaces.

Other Track Matters—Illustrated talks supplementing the several reports added interest to the proceedings. A new dynagraph or track-recorder car was described by Mr. Macomb, office engineer, Santa Fé Ry. Excessive wear of ties and different forms of American and foreign rail fastenings were reviewed by Mr. Von Schrenk, consulting engineer. In regard to the crushing of wood, even when protected by tieplates, Professor Talbot advocated securing the plate to the tie independently of the rail fastenings. In a progress report for the committee on Stresses in Railway Track, Professor Talbot referred to study of the action of the rail joint in carrying load and taking bending moments, but the exceeding complexity in the analysis of this action makes it impracticable to present conclusions as yet.

Bridges, Terminals and Freight Yards

Bridges and Buildings—Specifications for the waterproofing of solid-floor bridges by the membrane system, submitted by the committee on Iron and Steel Structures, were adopted after some discussion as to the requirements for asphalt. An important preliminary report was made on static and moving tests of the bearing value of large rollers, as basis for the design of

rolling bascule bridges. Notes of tests of columns now being carried on at the University of Wisconsin were presented by Professor Turneaure. Revised grading rules for lumber and a statement as to the value of treated timber for structures were adopted on recommendation of the committee on Wooden Bridges and Trestles. The committee on Wood Preservation advised eliminating the general requirement of the amount of creosote to be retained in the wood, submitting in its stead a table giving the desirable amounts for timber used for various purposes. A progress report was made on the marine piling investigation. In the discussion, a recommendation for methods of forced seasoning was suggested, but the committee opposed this as not being good practice, though sometimes used in emergency.

Revised specifications for plain and reinforced concrete and for portland cement, submitted by the committee on Masonry, were adopted, after several proposed amendments had been voted down. The concrete specifications are based largely on those of the Joint Committee, but omit "certain controversial theories, which include the section on flat slabs, columns and T-beams." Proportioning is in accordance with the theory of the water-cement ratio. The cement specifications are the same as adopted by the American Society for Testing Materials. Specifications for building materials were submitted by the committee on Buildings and were adopted but with some changes in those for structural iron and steel, particularly in limiting cast-iron columns to buildings of not more than two stories. This committee's report on steel sash indicated a general superiority to wood, provided that maintenance is not neglected. A review of various applications of concrete unit construction was supplemented by reports on substitute materials for wood and on plastic and composition floors.

Yards and Water Stations—Development and operation of joint passenger terminals was one of the main subjects presented by the committee on Yards and Terminals, with a form of agreement for the several railroads. Specifications for two-section track scales of the knife-edge type, and a complete revision and rearrangement of information on yards and terminals, were approved. Information was given also as to grades in gravity yards equipped with car retarders, but it was not considered desirable to submit typical hump profiles for gravity switching, since varying conditions make each yard an individual problem.

With reference to the economics of train service in relation to the spacing of water stations, the committee on Water Supply concludes that unnecessary water stations are a cause of many unnecessary train stops, involving expense in stopping and starting. On some roads these stops have been reduced materially by the introduction of larger tender tanks. Information was presented as to frost protection of water stations. The committee objects to the rules of the U. S. Public Health Service in regard to quality of drinking water supplies, on the ground that they are unnecessarily severe. As to relation of quality of water to locomotive service, Mr. Koyl (C., M. & St. P. Ry.) explained that experience on the New York Central Lines has supported the committee's former estimate that every pound of scale in a locomotive boiler costs 13c. in fuel and boiler repairs.

Specifications for storehouse construction and equipment, presented by the committee on Shops and Locomotive Terminals, recommended a 400-lb. live-load for the first floor when built over a basement, but this was changed to 300 lb. as a minimum. Information as to fire wall and dike protection for oil storage tanks included a recommendation that the capacity within the dike may be reduced if special construction is used to minimize splashing and wave action of the oil. Lightning protection for oil tanks was discussed by Mr. Kirkbride (Southern Pacific) and Mr. Jenkins (Baltimore & Ohio).

Economics and Miscellanies

As to the relative merits of ruling grades of 0.4 and 0.3 per cent, the committee on Economics of Railway Location stated that 0.3 is better than 0.4, while 0.2 is even better, provided there is sufficient traffic to justify the cost of securing it. This report went into considerable detail as to the study of grade revision and also included a paper on studies for electrification projects. All this material was accepted as information, after some general discussion as to the economics of grade revision and electrification. A method of determining the cost of stopping and starting trains by analysis of expense items incident to train service was submitted by the committee on Economics of Railway Operation, together with an extended progress report on branch line operation as affected by motor truck and bus service.

Excessive turnover of section labor would be greatly reduced if a comparatively uniform force was employed throughout the year, in the opinion of the committee on Economics of Railway Labor, whose report reviewed the various kinds of maintenance work practicable during the winter. As to the economy of labor-saving devices, the committee reported on ballast cars, ballast cleaning and dressing, tie tamping and track lining. Revised rules for the inspection of bridges, trestles and culverts, as submitted by the committee on Rules and Organization, were approved, as well as rules for building construction. Practice on different roads as to control and repair of work-train equipment was outlined. The committee on Uniform General Contract Forms submitted a revised form of construction contract and a form of agreement for purchase of water. These were adopted, while forms of agreement for joint use of freight terminals and for use of railway property for public highways were accepted as information.

A review of automatic train-control installations was the main feature of the report of the committee on Signals and Interlocking. But as to accident prevention, figures were given indicating the relatively small number of deaths that might be saved by such devices, even if all collisions could be prevented in this way, which is not the case. The committee on Electricity submitted progress reports on a variety of subjects, with revised specifications for rubber insulating tape. It also gave descriptions of four hydro-electric projects, including the Bay of Fundy tidal project and the St. Lawrence international project.

A lengthy explanation of the purpose and work of the American Engineering Standards Committee was the subject of the report of the committee on Standardization. Nothing was said as to the use or neglect of the association's standards by its own members. The special committee on Co-operation with Universities plans to secure more precise information as to the needs of the railways for college-trained men, and it submitted a proposed questionnaire for this purpose.

In regard to the convention plans, a report by the committee on Records and Accounts suggested sectional meetings, with three sections holding three sessions on each of the three days, and a general closing and business session for blanket approval (without discussion) of the resolutions adopted by the sectional meetings. The three general divisions would be: (1) Track, (2) structures, and (3) economics and general. The report was not presented, as the result of opposition on a point of order, the committee not having been instructed to consider the subject. But at the closing session it was voted to request the Board of Direction to consider the suggestions made in this report.

Control of Pedestrian Traffic at Chicago Proposed

Traffic Survey Recommends Ways of Controlling Foot Traffic Looking to Its Safety and Increased Speed of Vehicles

AMONG other recommendations made by the Metropolitan Street Traffic Survey, Chicago (abstracted in *Engineering News-Record*, Feb. 3, 1927, p. 193) was a recommendation for the control of pedestrian traffic both on the sidewalks and at the cross-walks. Studies of the movements of pedestrians in the loop district of Chicago show that the average speed of 3.16 miles per hour of persons walking on the streets during the free hours of the morning is reduced to 2.18 miles per hour during the hours of greatest congestion. Foot traffic and vehicle traffic concentration increases at the same hours of the day and each tends to interfere with and slow down the other. Consequently, the survey found it necessary to consider both and to make recommendations affecting them. Vehicular traffic is more susceptible to control than pedestrian traffic, but the survey believes that a reasonable measure of control can be placed upon the latter through a campaign of education before the regulations are put into effect and thereafter by careful and courteous control by the traffic officers with only arrest in case of malicious violations of the regulations.

Sidewalk Traffic—It is proposed that loitering be prohibited on crowded sidewalks and that where people have to stand they be required to stand close to the building line or to the curb line, that crowds be not allowed to congregate in front of display windows and that theaters provide sufficient lobby space so that the queues waiting for admission will not occupy street space. Also, it is recommended that as large new buildings are put up ample lobby space be provided and that wherever possible arcades be put through. The survey comments on the possibility of the use of subsurface sidewalks in connection with future subway construction at congested points. Rigid restrictions are recommended to limit the use of sidewalks for piling merchandise and building materials. News stands and other obstructions to sidewalks should be eliminated as fast as possible.

Cross-Walk Traffic—In the matter of controlling foot traffic across the streets, the survey recommends that in the business district jay-walking be prohibited and that the cross-walks should be of a width equal to or greater than the sidewalk width and clearly marked upon the pavement. In blocks where the distance between intersections is greater than 400 ft., mid-block cross-walks should be established. In these districts operators of vehicles should be forbidden to enter the space assigned to cross-walks until pedestrians desiring to cross have exercised their right-of-way, and at crossways not so marked pedestrians should be required to give a reasonable and visible signal before attempting to exercise their right-of-way. The movement of pedestrians across the restricted cross-walks should be controlled by the traffic lights with certain modifications, if desirable, in the case of crossings where traffic officers are stationed. Pedestrians are to be given right-of-way over vehicles wishing to make a right or left turn. Pedestrians, on the other hand, are to be prohibited from leaving the curb line and crowding out into the traffic lanes to restrict the movement of traffic while waiting for the signals to change.

The survey points out that in order to have the pedestrians conform to such regulations, the traffic signal system will have to be carefully adjusted so that they will not be subjected to long waits when there is no traffic or little traffic passing in the cross direction.

In wide streets and where there are trolley stops, the survey suggests the use of safety platforms or safety zones. The use of safety zones is recommended for all non-traction streets where the roadway exceeds 60 ft. in width and where there is a large volume of pedestrian traffic. In places where there is an unusual volume of pedestrian traffic, the possible use of pedestrian bridges or pedestrian subways should be considered.

Tentative Conclusions from Arch Dam Test at Stevenson Creek

TEST work to date on the Stevenson Creek experimental arch dam in California has included deflection and stress measurements under various heads of water up to the full height of the dam, 60 ft. These measurements have led to the following tentative conclusions:

(1) The load carried due to the horizontal thrust in the horizontal elements (the so-called arch ribs) has been quite fully determined for all parts of the dam under the 60-ft. head. There is, however, still some doubt about the loads near the bottom, or up to the 10-ft. elevation. The load so carried reached a maximum about mid-height. It decreases regularly to a smaller amount at the top. Below mid-height the load so carried is nearly constant until a point close to the bottom is reached, where it appears to decrease rapidly.

(2) The load carried by bending of the horizontal elements has been determined approximately at certain places. The indication is that the intensity of the load so carried decreases from the center toward the abutments, even becoming negative at the abutments in some cases.

(3) The load carried by bending of the vertical elements has been partly determined for certain vertical sections. Evidently, in the lower half of the dam a much larger proportion of the load is so carried than in the upper half. In fact, near the top the vertical elements seem to be partially supported by the horizontal elements.

The investigation is being carried out by a committee of Engineering Foundation, with Professor Charles D. Marx as chairman and Fred A. Noetzli as secretary. W. A. Slater of the Bureau of Standards has been in charge of the measurements. A plot of deflections of the dam under full head was reproduced in *Engineering News-Record*, Nov. 18, 1926, p. 828.

Water Rates of Milwaukee Upheld by the Wisconsin Railroad Commission

City May Charge Same Meter Rate to All, Pay Works Only $10 Hydrant Rental and Earn 8 Per Cent Return—Latter Not Done But Rates Approved as Exercise of Managerial Discretion

A UNIFORM meter rate for all water sold by the Milwaukee water-works within the city and a higher but also uniform rate for metered water sold outside the city has been approved by the Railroad Commission of Wisconsin. The commission holds that, although the rate schedule calls for one price for metered water regardless of the amount consumed, there is nevertheless a wide range between what large and small consumers actually pay for water. This conclusion rests on the fact that the first cost of water main extensions, service connections and meters is met by meter users and the further fact that the meter service charge is the same for all consumers. The commission also approved the fire protection charge of $10 per hydrant paid by the city into the water-works fund, although holding that the revenue thus afforded does not equal the cost of providing and maintaining the hydrants alone without making any allowance for the capital and operating costs of mains and pumping stations. The water-works as a whole, the commission finds, is not giving a proper return upon the investment. Notwithstanding this and other defects in the financing of the water-works, the rates established by the city and filed with the commission are approved by the latter.

The commission bases its approval on its opinion that as the rates are not excessive, unjust, or unjustly discriminatory, the city is entitled to exercise managerial discretion as to what the rates shall be. Further justification of the rates is found in the commission's opinion that since the providing of capital for the water-works is done at a lower interest rate than would be the case under private ownership, due to the security afforded by all the property of the taxpayers of the city, the city is entitled to a "return" that will reflect this saving. It should be noted that the entire outstanding water-works indebtedness of Milwaukee is only $105,000. This is due to the use of earnings to meet the cost of the works and to assessing the cost of main extensions on abutting property owners.

The Milwaukee Case—Before going further it may be noted that Wisconsin is one of a very few states in the Union which has given to its utility regulating body the power to control rates charged by municipally owned water-works. Milwaukee secured legislative action excluding it from the jurisdiction of the commission in the respect just indicated, but not long ago the State Supreme Court held the exemption illegal. Thereafter the city of Milwaukee filed the schedule of rates which it has been actually charging for some years past and which the commission approved on Dec. 9, 1926. In accordance with statutory requirements, the commission gave hearings on the schedule of rates. Opposition to the schedule was voiced by representatives of a considerable number of large water users, including brewing, dyeing, leather, soap and laundry companies, the Milwaukee Coke & Gas Co., and the Chicago, Milwaukee & St. Paul Railroad Company.

Basis of Valuation—The commission states that the city made no attempt to support any particular figure as the value of its property, but that there is on record an estimate of reproduction cost on Jan. 1, 1925, of about $33,000,000, including allowances for additions and working capital for the year 1925 that would bring the total up to $33,500,000 at the close of the year, regardless of how the property was acquired and financed. City's book value of its property, Dec. 31, 1925, was $17,200,000, including $440,000 of so-called "park property." The record also showed a total collection of some $2,450,000 special assessments for extensions of the distribution up to the close of 1925. It is only since 1912 that the Water Department has credited its "plant account with the original cost of property retired from service" and, the commission states, "there is nothing in the record to indicate to what extent the property and plant account at the present time may include charges for property which has since been discarded."

The depreciation reserve account on Dec. 31, 1925, amounted to $1,576,000—apparently computed on the so-called "straight-line method." The superintendent of water-works states that the city would probably not have carried the depreciation reserve if the requirements of the commission had not made it necessary. The commission then adds that the contributions to reserve account figured by this method are in excess of the method recommended by the commission, but not followed by the city of Milwaukee. Notwithstanding the fact just stated, the city claimed "that there is no accrued depreciation, except possibly in the case of a few individual items of property which are about to be retired from service." To this claim the commission states it cannot give serious consideration. The commission also says that in view of the circumstances pertaining to this case, the only available measure of accrued depreciation—and that, it thinks, is "imperfect"—is "the amount of the accumulated reserve."

After deducting $213,500 for property which the commission thinks is "no longer used and useful," and after allowing for working capital, the commission settles on $33,300,000 as "an estimate of cost of reproduction." Further: "We have also a statement of original cost, which, to be entirely conclusive, should be corrected on account of property retired prior to 1913 which has not been written off, and on account of a discontinued high service station." What these deductions should be the commission does not state. Instead, it announces that it still holds to the opinion as to "the use of cost of reproduction at current prices as an element in determining value" which it stated in a Duluth street railway case previously ruled on by the commission (presumably as regards service rendered in Wisconsin by the street railway system mentioned). What this has been is not stated in the opinion, which then continues:

"After careful study of all the facts, and after giving such weight as we think reasonable and proper to the

increased cost of construction over levels prevailing in earlier years, and after excluding, because of special assessments paid by private owners, the amount of $2,443,456, it is our conclusion that $17,000,000 represents the amount on which the city may reasonably ask for a return." Earlier in the opinion it is stated in passing that the city's expert witness estimated "going concern value" at $2,500,000. What weight the commission gave to this figure, there is nothing in the opinion to indicate.

Rate Basis—In taking up the question of proper rates, the commission first accepts the city's record of total revenue actually received as about $2,220,000, of which all is for sales of water except some $5,000 for penalties and $15,000 for meter repairs. Lengthy consideration is then given to operation and maintenance expenses, depreciation and taxes. The commission passes over a charge to maintenance for overhauling pumping equipment which "amounted to substantial rebuilding" since the total maintenance expense for 1925 was only $58,600.

Under depreciation, after referring again to its opinion in the Duluth street railway case, the present opinion states: "Where no deduction is made from the rate basis on account of accruing depreciation, we see no logic in making the provision for the reserve on a straight-line basis, and the practice of the commission has been to use a sinking-fund basis for making the computation." The 1925 depreciation figure used by the city was about $183,000, apparently "computed on a 'no interest' basis on a depreciable value of" about $13,000,000, or at the rate of about 1.4 per cent per year. This indicates an average life expectancy of 71 years. To meet this would require an annual charge to operating expenses, on a 70-year basis, but with the substitution of the commission's 5 per cent sinking-fund basis, of 0.0017 per cent. Taking depreciable property at about $17,500,000 and using a depreciation rate of 0.0017 a year, "the annual requirement as a charge to operating expenses" on account of depreciation "would be $29,750." Substituting a 70-year life as in accordance with "sound-business policy to make provision on a basis which will protect the city against such variations in the life of property," etc., this would require an annual charge at the rate of 0.00283, or in round numbers $50,000 a year, which figure the commission adopts.

It may be noted here that although the $2,450,000 paid by property owners as special assessments for main extensions is excluded from the rate basis that sum is included in the depreciation base.

Taxes—Taxes are then considered. A city exhibit showed a general property tax on its water-works of $739,174, a state income tax of $34,205, and a federal income tax of $77,321; or a total of a little over $850,000. The city's expert, the commission says, "undertakes to support the claim for taxes on the ground that provision for taxes as an operating expense is necessary in order to keep a proper balance between customers and property holders in the city." The commission adds: "We have previously held that general property taxes computed at the local tax rate, excluding state and county taxes, are properly to be included among the expenses of a municipally owned utility." Since there is no way for transferring the "state and county proportion of general property taxes" to the state and since "the inclusion of provisions for such taxes among the operating expenses of a municipal plant is not necessary in order to equalize the burden between customers and other taxpayers" and since to do so would "simply throw a burden upon users of water which, in our opinion, should not be placed there," state and county taxes are excluded as an addition to operating expenses. The federal tax is excluded on the same ground. For the state income tax the commission holds that such part of it "as would revert to the city if the utility were privately owned may properly be included among the expenses of the municipally owned plant."

After going into details as to local taxation, the commission allows a charge against operating expenses on account of the general property tax of $390,000 and a state income tax of $32,000. The final operating and capital charges figured by the commission are about $615,000 for "direct expense of operation and maintenance," $50,000 for depreciation and $422,000 for taxes, making a total annual operating charge of about $1,087,000. Deducting this figure from operating revenues of some $2,205,000 leaves about $1,118,000 "available for return." The opinion next points out that the books of the Milwaukee Water Department allow nothing for services rendered by other city departments nor for rent of space in the city hall, all of which "would be of material consequence." These items, however, are passed over by the commission.

Meter Charges—The one-price system in force in Milwaukee for metered water is next given attention. On the one hand the city presented to the commission a resolution urging the commission not to change the one-price method, while on the other "the attitude of a number of the customers of the Milwaukee water-works indicates that at least for some of the customers the present rate system has not proved satisfactory." The rate in force is 7c. per 100 cu.ft. or 9½c. per 1,000 gal. for consumers within the city and 10c. and 13½c. respectively outside the city, with a uniform charge of $2 a year, regardless of size of meter "to meet the cost of accounting, meter rating, delivery of bills, collection of accounts," etc.

Before going into a detailed consideration of the meter rate schedule, the commission calls attention to the fact that nothing in the statutes authorizing it to regulate rates charged for water supplied by municipally owned plants requires that "the rate shall exactly reflect the cost of service." Instead, the power of the commission is to prevent rates that are "unjust, unreasonable, insufficient, or unjustly discriminatory," etc. The city maintained, through the testimony introduced by it, that the "cost curve" is to be regarded as "only a step in arriving at a proper schedule of rates" and "that the determination of the schedule to be charged, assuming that the total return is not to be excessive, is largely a function of management." In the end the commission gave material if not full weight to this claim of the city.

The commission points out that "methods of determining cost rely for the accuracy of their results largely on the soundness of the judgment of the individual making the determination." The commission also laid stress on the difficulties involved in apportioning the cost of service between different classes of users and different users in the same class. It said: "Generally speaking, in the business of supplying electric service, the cost of serving various classes is quite fully reflected in the rate schedules, as nearly as that cost can be determined. In the gas business, at least within our ex-

perience, this is not true to the same extent, and the same condition prevails in the water-supply business. In the electrical business, also, a good deal has been done towards so adjusting the schedule that each individual within the class has a rate adapted to the cost of serving him. In this regard practically nothing has been done in the gas and water-supply business, and nothing in the telephone business except in those instances where measured service prevails."

Investment Return—Permissible rate of return on the water-works investment of the city is finally named by the commission as 8 per cent. The commission apparently accepts the claim of the city "that it is entitled to the same return as a private utility would be entitled to, and that the saving which it is able to accomplish in the cost of securing capital properly belongs to it." The commission also takes into consideration the fact that at the end of the year 1925 the city had outstanding only $105,000 of water-works bonds, the records showing "that aside from special assessments, the construction of the water-works had been entirely paid for out of earnings, and that, in addition, substantial amounts had been turned into the general fund." In the opinion of the commission, "the record does not show that the earnings of the water department have been excessive or that it has been financed, either in whole or in part, out of earnings over and above a fair and reasonable return." On an 8 per cent return basis and with a rate base of $17,000,000, a total of $1,360,000 would be required as net return, whereas, after making all the allowances cited above, the income "fell short of providing the return to which the city may be entitled by $241,833." Consequently, the commission states, "so far as the total earnings of the Milwaukee Water-works Department are concerned, we cannot hold that they have been excessive."

Fire Protection Charge—Fire service of $10 a hydrant is next considered in view of the fact that there has been "criticism of the distribution reflected on the books of the department between fire protection service and general service." The protestants argued that on the common basis of "the construction of co-ordinate plants to furnish the two classes of service, the cost of fire protection service would be very much in excess of the amount paid for hydrant rental by the city, and we think that there is no question as to the correctness of this position." But, on the other hand, the city "has taken the position that the cost of fire protection service should not be computed on the basis of division of property" as above stated. In support of this claim, the city adds that the amount of water used for fire protection is practically negligible and that the city has a separate fire fighting system in the congested area.

Although the Wisconsin Public Service law does not classify sewerage as a utility, the commission in its opinion under review brings in the equity and propriety of so doing this as having a bearing upon the water rate case before it. Under this head it states that "municipal sewerage systems furnish a service whose cost differs for different individuals and for different states of industrial and commercial establishments, which difference is not accurately measured by differences in taxes levied." It adds: "If it is indefensible to establish rates for water service which depart more or less widely from the cost curve, it seems to us that the same criticism must apply to the distribution of the cost of furnishing sewer service." Quite regardless of the stand taken by the city, the commission expresses as its own belief that it "would not be bound to fix rates for water in accordance with the cost curve" and adds "that some consideration may properly be given to the managerial functions of the city in the determination of the type of schedule."

The commission concludes that the $45,970 paid by the city for fire protection (at the rate of $10 a hydrant), is insufficient and that "whether reflected on" the books of the city or not "the burden of the city amounts, not to $45,970, but to $287,802." Notwithstanding this conclusion, the commission states it is not prepared to say that this is an evidence of "unjust discrimination against the users of general service."

The One-Price Question—Coming next to the specific matter of the one-price metered water charge in Milwaukee regardless of the amount of water consumed, the commission refers to an exhibit by the city "which attempts to show that the average charges per 1,000 gal. for water used in annual quantities of from 10,000 gal. to 500,000 gal." vary from 61.8 per 1,000 gal. for smaller quantities to 9.34 for the larger quantities. This variation appears to be based on calculations taking into account what water users have actually paid in the way of special assessments for water main extensions and for the cost of installing service connections and meters. Account also is taken of the fact that there is the same charge of $2 a year for a meter regardless of its size.

Schedule Upheld—Finally, the commission approves the Milwaukee rate schedule because: "We have, then, the situation that the present meter rate is, in fact, not a uniform meter rate, but that it does result, when all the facts are considered, in a much higher charge per unit of consumption for the small customers than for the large customers, and that to the extent that this is true it approximates the form of the cost curve. We have the fact, also, that the statute does not require that rates be based strictly on the form of the cost curve, and the further consideration that to an extent which we will not attempt to define the form of rate schedule to be applied lies within the field of management. After considering all the facts, we are unable to determine that the schedule which the city of Milwaukee has filed and which is here under investigation is unjust, unreasonable, or unjustly discriminatory."

Pumping Station Fire Burning Since 1849

With a transfer of live coals from an old station to a new one, a continuous fire has been maintained at the pumping stations of the York Water Co. (Pa.) since 1849. The record is given as follows in a pamphlet on the 111-year history of these works just published by the company: "There is a tradition that in 1849 a certain John McLaughlin, while sitting on a bench in the boiler room of the original pumping station along King's Mill Road, smoking his pipe, was approached by one of the engineers who was testing the new pump and boiler and asked to furnish fire from his clay pipe to start the fire beneath the new boiler. This fire continued burning until the boilers in the present pumping station were completed in 1897, when some of the fuel was carried by the late superintendent, Jacob L. Kuehn, in a plumber's furnace, from the old station to the new one, where the fires in the present boiler room were kindled and have never since been extinguished."

Strength Tests of 69 Large Steel Solid-Web Columns

Capacity Determined by Yield-Point—Efficiencies from 80 to 90 Per Cent—Coupon Tests Are Variable

TWO SERIES of tests of heavy solid-web columns, 69 in all, carried out at the Bureau of Standards during the last three or four years, have just been reported upon (Technologic Paper 328). Their general result is to confirm the view heretofore held that the strength of steel columns of moderate length is determined by the yield-point of the material and lies 10 to 20 per cent below the drop-of-beam yield-point.

The particular construction (solid rolled or built up) was found to have no recognizable effect on the column strength. Variability of material, however, proved to

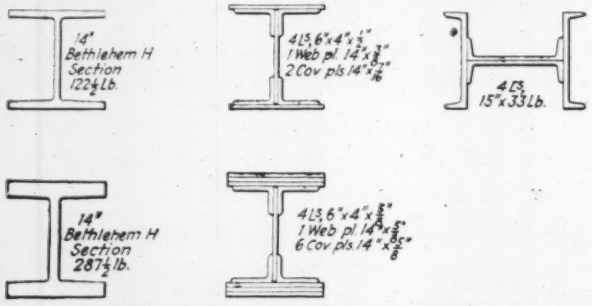

14" Bethlehem H Section 122½ Lb.
4 L 3.6"x4"x⅝"
1 Web pl. 14"x⅜"
2 Cov pls 14"x7/16"
4 L's 15"x33 Lb.
14" Bethlehem H Section 287½ Lb.
4 L 3.6"x4"x⅞"
1 Web pl 14"x⅝"
6 Cov pls 14"x⅞"

FIG. 1—SECTIONS OF COLUMNS TESTED

be important, and it was found necessary to use a large number of specimen tensile tests to obtain a reliable value for yield-point of material. Moreover, the speed of the testing machine in the specimen tests was an important factor, slow speed being necessary to get dependable indications. The values of yield-point found at the Bureau of Standards were found to differ considerably from those reported in the mill tests, though both sets of tests were made by the drop-of-beam method.

The columns tested ranged from 1,000,000 to 3,000,000 lb. capacity at ultimate strength. So-called light columns of about 35 sq.in., and heavy columns of about 85 sq.in. cross-section were tested. Their lengths were 12, 18 and 24 ft. (slenderness ratios ranging from 38 to 92. This range of length was so small that on the average only 6 per cent decrease of column strength was observed as between the short and the long columns, and the tests therefore were of chief value in their bearing on the relation of column strength to yield-point and method of construction.

In the first series of tests, made for the American Bridge Co., the material was commercial structural steel, bought in the open market, and came within the usual strength range of 55,000 to 65,000 lb. per sq.in. In the second series, for the Bethlehem Steel Co., the material was rolled in that company's mills and was selected to represent two grades, the first bordering on the lower tensile strength of the range indicated (55,000 lb. per sq.in.), while the other bordered on the upper limit of the manufacturers' standard specifications (70,000 lb. per sq.in.). The two test series were carried out at different times and by different personnel. For the second series a much larger number of coupon tests was taken then for the first series, with a view to giving more complete correlation of the strength of the column and of the material.

Fig. 1 shows the column sections tested. The solid rolled columns were 14-in. H-sections weighing respectively 122½ and 287½ lb. per linear foot. The built-up I-sections had about the same sectional area and overall dimensions. Three columns were built up of four channels to give a cross-section generally similar to that of the "light" columns. As already noted, the test lengths were 12, 18 and 24 ft.; but in the second series the 18-ft. lengths were omitted as giving no additional information, and some of the 24-ft. columns were cut to

RESULTS OF 69 COLUMN TESTS

Letters in second column denote: F, built-up I-section; R, rolled I-section; C, section built up of channels; S, steel of 55,000 lb. minimum strength; T, steel of 70,000 lb. maximum strength; L, light section, 35 sq.in.; H, heavy section, 85 sq.in.

Series	Column		$\frac{l}{r}$	Column strength	Ratio to Tensile strength	Average	Efficiency	Average
				Lb./in².				
1	FSL 12	a	45.9	36,550	0.559	0.555	0.892	0.882
1		b	45.9	35,810	.548		.873	.882
1		c	45.9	36,330	.557		.882	
2		d	45.8	33,680	.587		.884	
2		e	45.8	32,000	.559	.575	.842	.862
2		f	45.8	32,890	.578		.860	
1	FSL 18	a	68.8	32,720	.510	.513	.834	.843
1		b	68.8	33,230	.508		.846	
1		c	68.8	*32,400	.521		.850	
1	FSL 24	a	91.7	31,580	.517	.501	.804	.790
1		b	91.7	30,930	.475		.773	
1		c	91.7	31,180	.510		.794	
2		d	89.8	31,910	.563	.551	.857	.847
2		e	89.8	30,950	.552		.853	
2		f	89.8	30,000	.537		.832	
1	FSH12	a	40.4	37,640	.592	.600	.976	.972
1		b	40.4	36,270	.588		.949	
1		c	40.4	37,070	.621		.990	
2		d	40.4	31,830	.561	.555	.940	.924
2		e	40.4	31,820	.557		.908	
2		f	40.4	31,010	.547		.924	
1	FSH18	a	60.6	31,200	.523	.524	.874	.872
1		b	60.6	30,720	.522		.870	
1		c	60.6	*31,260	.527		.872	
1	FSH 24	a	80.8	32,860	.500	.499	.826	.827
1		b	80.8	30,500	.511		.850	
1		c	80.8	30,240	.487		.804	
2		d	79.2	30,320	.532	.529	.890	.885
2		e	79.2	30,000	.527		.882	
2		f	79.2	30,000	.528		.882	
1	CSL 24	a	70.8	34,020	.595	.604	.795	.808
1		b	70.8	33,910	.593		.792	
1		c	70.8	35,760	.625		.836	
1	BSL 12	a	40.5	35,000	.566	.576	.862	.876
1		b	40.5	35,640	.590		.896	
1		d	40.5	35,830	.573		.871	
2		d	40.5	32,120	.564	.556	.834	.808
2		e	40.5	31,500	.552		.801	
2		f	40.5	32,180	.552		.788	
1	BSL 18	a	60.8	*35,790	.564	.558	.893	.874
1		b	60.8	35,000	.562		.856	
1		c	60.8	35,350	.547		.873	
1	BSL 24	a	81.0	37,860	.583	.554	.844	.828
1		b	81.0	35,260	.526		.823	
1		c	81.0	36,810	.553		.816	
2		d	81.0	31,960	.554	.536	.798	.777
2		e	81.0	31,060	.529		.764	
2		f	81.0	30,120	.526		.768	
1	BSH 12	a	37.8	28,200	.445	.444	.808	.818
1		b	37.8	25,760	.446		.845	
1		c	37.8	25,860	.440		.801	
2		d	37.8	34,000	.602	.603	.847	.840
2		e	37.8	35,980	.606		.847	
2		f	37.8	35,000	.601		.827	
1	BSH 18	a	56.7	26,670	.425	.438	.793	.814
1		b	56.7	*25,280	.428		.843	
1		c	56.7	26,710	.460		.806	
1	BSH 24	a	76.5	28,440	.452	.441	.809	.816
1		b	76.5	24,500	.420		.781	
1		c	76.5	28,680	.450		.858	
2		d	74.0	34,370	.604	.607	.842	.855
2		e	74.0	36,000	.623		.887	
2		f	74.0	33,600	.594		.836	
2	BTH12	d	37.8	39,410	.584	.597	.860	.864
2		e	37.8	41,010	.610		.862	
2		f	37.8	41,010	.597		.869	
2	BTH24	d	75.6	39,740	.581	.568	.827	.830
2		e	75.6	38,620	.568		.840	
2		f	75.6	38,120	.556		.822	

* Average of test and retest. Difference of the two values negligible.

23½ ft. for convenience in manipulation in the machine.

Special care was taken in centering the columns in the testing machine; in most of the tests the comparative readings of compressometers at the four corners were used as guides in centering. The testing machines were calibrated. Load was applied in stages during the

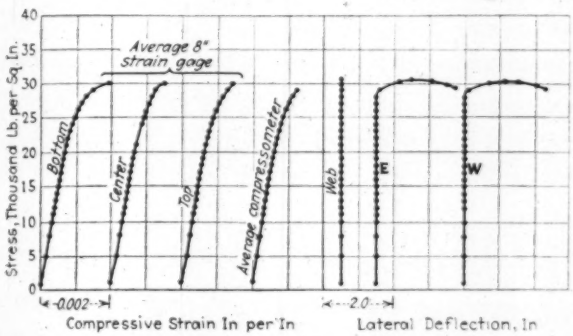


FIG. 2—DEFORMATIONS AND DEFLECTIONS OF A TYPICAL HEAVY COLUMN

early part of the testing, with occasional release of load, but at the higher loads was applied continuously by the pumps which supplied the hydraulic cylinder of the machine. In the first series the testing was stopped when the maximum load had been passed; but as one column, in which the maximum load accidentally was not measured, went to much higher loads as the machine continued to apply further strain, the columns of the second series were all tested to loads beyond the first maximum, to observe whether they maintained or increased their strength beyond this point.

A typical plot of test results on one column (heavy built-up section) is given in Fig. 2, showing at the left the compressometer readings (stress-strain curves) and at the right curves of lateral deflection. It will be seen that the deflection was insignificant up to failure, and then increased rapidly to a large amount. No local failure occurred in the entire series of tests, because of the sturdy construction of the columns; the results, therefore, represent the strength of the column as an integral member.

The results are summarized in the adjoining table and graphically in Fig. 3, where (1) column strength in pounds per square inch and (2) column efficiency, or ratio of column strength to tensile yield-point, are plotted on a base of slenderness ratio. These two diagrams clearly show that the effect of length of column was insignificant within the test range. With a more accurate system of weighting the coupon specimen yield-points, the curves of Fig. 3, right, could be brought still closer together, but this weighting could not be applied to all columns of the two series, because of differences in the location of the coupons.

The marked difference between the two plots in Fig. 3 brings out the important effect of the material composing the column. This became apparent during the first series of tests, and was one of the reasons for selecting a much larger set of coupon tests in the second series. By referring the strength of each column to the weighted yield-point value of the material as determined from the coupon tests, the results are made very uniform, as the right-hand plot shows. In other words, the column efficiency is substantially the same for all the columns, 80 to 90 per cent.

The conclusions drawn by the authors of the report (Dr. L. B. Tuckerman and A. H. Stang) comprise the following important points:

No difference in column strength definitely attributable to difference in type of construction could be found. Within the range of slenderness ratio of 40 to 90 only a small decrease of column strength was observed, about 6 per cent. The column efficiency (ratio of column strength to average tensile yield-point of the material) was fairly constant, while no such constant relationship was found between the other properties measured. Yield-point determined in the commercial mill tests apparently bore no relation to the strength of the columns.

Bearing on determination of yield-point, it is reported that the yield-point by drop of beam at speeds 0.013 and 0.37 in. per minute showed a systematic difference of about 12 per cent. On the other hand, differences as great as 27 per cent were found between the drop-of-beam yield-point measured at the mill and at the Bureau of Standards, although the ultimate strengths determined in the two laboratories were substantially the same.

"Pick-Up" of Load—In one of the heavy solid rolled columns of the first series there was only a slight momentary falling off of load at approximately the ex-

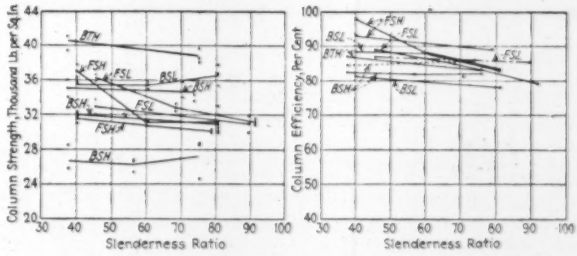


FIG. 3—COLUMN STRENGTHS AND EFFICIENCIES

Efficiency is ratio of column strength to weighted average tensile yield-point of specimens. The efficiency plot, at the right, is based on a particular grouping of specimens. A more accurate system of weighting tends to bring the lines still closer together, but this could not be applied to all the columns because of the location of the coupon specimens.

pected maximum load point, after which, with continued operation of the pumps, the resistance of the column continued to increase until it was nearly a third greater than the load just mentioned (37,600 as compared with 28,200 lb. per sq.in.). At this time the weighing beam of the testing machine still showed no sign of dropping, but the column had deflected so much that further testing would have been dangerous.

This phenomenon of pick-up of load was therefore more fully studied in the second series of tests, all columns being carried considerably beyond their first maximum load. A number of these columns showed either a maintained or nearly maintained load capacity after the first maximum; in four cases out of the 30 the carrying capacity of the column increased beyond the first maximum, by 5 to 15 per cent. The phenomenon, which has been observed before, is given considerable discussion in the report. The report says, however, "The second maximum values represent a state of very precarious stability of the column. These second maxima cannot, therefore, furnish any reliable measure of safety of a column in practice. On the other hand, the practically definite first maximum stress, occurring before any appreciable lateral deflection of the column, and fairly reproducible when the column material and test conditions are reproduced, should furnish a good measure of the strength of the column in practical use."

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

Machinery of Movable Bridges

REVIEWED BY HOWARD C. BAIRD
Consulting Engineer, New York City

MOVABLE BRIDGES—By Otis Ellis Hovey, B.S., C.E., M.Am. Soc.C.E., M.Am.Soc.M.E., Etc., Assistant Engineer of American Bridge Co. Vol. II, Machinery. New York: John Wiley & Sons; London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 344; illustrated. $6.

This work, devoted to the machinery of movable bridges, just as the first volume is devoted to their superstructure, is the outcome of many years' experience in the design of such structures, and has the value of presenting examples of practical operation. The rare combination of terse methematical demonstration of theoretical principles with the examples of actual machinery worked out in all details attracts the engineer by its clarity and directness. The theoretical treatment is applied mechanics confined to special problems worked out from beginning to end in the design of machinery actually constructed and satisfactorily operated. Incidentally, the reader gains the knowledge of many factors governing the operation of drawbridge machinery, which might be called the results of laboratory tests, the laboratory being the many railroads and highways of this country, and the tests the constant operation under all kinds of adverse conditions year in and year out.

The introductory chapter gives a general dissertation on the various factors necessary to be considered in approaching the design of drawbridge machinery, such as power, arrangement of machinery, gearing, etc. In Chap. II, Power, the student is carried through the general arrangement of machinery, machinery resistances, design of machinery parts, such as shafts, coulpings, bearing, gearing, levers, etc. Some comparatively new matter in bridge literature deals with the development of the modern vertical lift, such as sheaves and wire rope, etc. Large trunnions and brakes, as used in heavy bascules, are taken up. Of special note are the formulas and tables for loss of hydraulic pressure in straight pipes, the formulas giving the loss in pounds per square inch for a straight pipe 1 ft. long with a given diameter in inches, a great improvement over the cumbersome formula in general use. Loss of pressure in a 90-deg. bend and in pipe fittings is also simplified, greatly to the convenience of the designer.

The importance of brake design, and particularly the necessity for rigid supports for brake machinery, is brought out in Chap. III and the mathematical treatment of the forces involved is thoroughly presented.

The subject matter is exceedingly well arranged; the only point open to criticism is that Chap. IV, Materials of Construction, might have been placed to better advantage among the appendices with Specifications. Such problems as time of operation for a given power, resistance to turning of a swing span in still air and against wind, together with a clear demonstration of the relation of velocity, time and space, are lucidly presented and the practical application of these problems is admirably shown in the examples completely worked out as they would be in the designer's office. The text is accompanied by cuts from general drawings of operating and latching machinery for several kinds of swing span, and examples of the Chicago and Strauss types of bascule and a vertical lift span. These cuts are generally from assembly plans or shop drawings used in field and shop and are therefore complete and accurate.

The subject of machinery resistance is covered by considerable explanatory matter, in addition to computations which are instructive and easily followed. The tables of resistances for different machine elements are useful to the designer, as are also the charts showing characteristics of electric motors and gasoline engines.

The chapters on shafts, couplings and keys, and on journals, bearings, pivots and collars, are each prefaced with a derivation of the formulas used in designing such parts and contain full tables giving capacities of shafts, standard dimensions of keys and pedestals such as are in present-day use in movable bridge machinery.

The theory of contact of gear teeth and the development of exact theoretical tooth forms is wisely omitted, reference to standard works being given as sufficient to enable anyone desiring it to go into subjects which necessarily require almost unlimited space in their fundamental treatment. The strength of gear teeth and gear wheel arms is adequately covered, as is also the theory of slow moving wheels and worms and the theory of screws and nuts, accompanied by the usual convenient tables. In addition to tables of strength, etc., Table 9N—something entirely new, so far as the writer knows—giving approximately weights of spur gears corresponding to given torsional moments, is of inestimable value to the designer desiring to make a quick estimate of weights.

The appendices form an important part of the book. Appendix A gives complete specifications for movable bridges, embracing general design, details of operating machinery, sheaves and wire rope, power equipment, loads and stresses for superstructure, unit stresses, materials, workmanship, and erection. Appendix B contains the theory of sheaves loaded by ropes under tension and gives the entire computation of stresses, direct and secondary, in a large sheave. Appendix C, Tables of Miscellaneous Data, gives in compact form the elementary mechanical principles required to design machinery: Moments, slopes, deflections, etc., of beams and cantilevers as applied to shafting and machinery supports; also mensuration of surfaces and solids, center of gravity, elements of sections and solids. All this matter is, of course, found elsewhere, but the advantage to the reader in having it all at hand for use in following the mathematical demonstrations, or in attacking new problems with the aid of this book, must be obvious.

Movable Bridges in its two volumes forms as serviceable an aid to the designing engineer and as thorough a textbook for the student as anything in modern engineering literature. The index shows the same thoroughness and painstaking labor which characterize the preparation of the work.

[Vol. I of this work was reviewed by Mr. Baird in these columns, July 15, 1926, p. 110.—EDITOR.]

Beginnings of a Great Railroad

THE BEGINNINGS OF THE NEW YORK CENTRAL RAILROAD: A HISTORY—By Frank Walker Stevens. New York and London: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. 403; halftones, portraits and line cuts. $4.

In 1853 eight railroad companies, with lines extending from the Hudson River at Troy and Albany westward to Buffalo and Niagara Falls, consolidated to form the New York Central Rail Road Co. Two other companies were included in the consolidation but they represented only strategic "paper" railroads. This was the first great railroad consolidation, the inevitable result of a demand for faster and more direct communication with the West than could possibly be given by the Erie canal or the little independently operated railroads connecting the chief cities across the state of New York.

Between 1826, when the Mohawk & Hudson R.R., the first of the companies forming the new railroad, was organized, and the date of the consolidation is a quarter century whose record is that of a long struggle to develop railroads from a little known curiosity to an essential part of the transportation system of the country. Not only did the skepticism of a large part of the people have to be overcome, but also the opposition of those who saw the railroads as a source of competition with the canals. It is with the record of these years as found in the papers, reports and other documents of the railroads forming the new organization that this history deals.

For the civil engineer, it has a special interest. In it are given the preliminary estimates of the cost of the Mohawk & Hudson R.R., prepared more than a century ago when railroad construction was an unknown art. Actual cost figures also are given: 9c. a yard for excavating clay and 11c. for placing it in embankments. Then, too, there are detailed drawings of the track structure designed by John B. Jervis, the chief engineer of the Mohawk & Hudson at the time it was built, drawings of one of the earlier timber bridges, and of the curious rail sections which followed the earlier strap rails.

Accuracy was the basic requirement laid down by the author in planning his work. He set out to make an authentic record, rather than an interesting narrative, but he has succeeded in producing both.

Science of Buying Transportation Service

TRAFFIC MANAGEMENT—By G. Lloyd Wilson, Ph.D., Assistant Professor of Commerce and Transportation, Wharton School of Finance and Commerce, University of Pennsylvania; formerly Traffic Manager of the Chester Shipbuilding Co., Ltd., and the Merchant Shipbuilding Corporation. [Appleton Railway Series, Edited by Emory R. Johnson, Ph.D., Sc.D.] New York and London: D. Appleton & Co. Cloth; 6 x 9 in.; pp. 453; 72 line cuts. $3.50.

For years the railroad companies have been developing the science of selling their services to the public, but industries only recently have begun to make scientific studies of their requirements along the same lines, depending largely upon the advice of the men in the railroad field. The exigencies of the war days altered this situation and forced upon the larger industrial concerns the work of solving their own traffic problems. The most noteworthy outgrowth of that experience was the organization of the shippers' regional advisory boards which are now functioning in the various sections of the country. It is with the industrial side of traffic management that this book deals, industrial traffic management as differentiated from commercial traffic management.

The first part of the book takes up the function of industrial and commercial traffic departments, management of shipping and receipt of freight, management of transportation within the industrial plant, and freight claims. The second part of the book deals with organization and administration, and the third part with the broader field of traffic management, such as traffic service bureaus, procedure before traffic committees and regulatory commissions, and co-operation in the traffic field. The book should be of value to all those who are charged with buying transportation services for the larger industrial concerns.

Exposition of an Evil Tendency

MAIN STREET AND WALL STREET—By William Z. Ripley, Nathaniel Ropes Professor of Political Economy, Harvard University. Boston: Little, Brown & Co. Cloth; 6x9 in.; pp. 359; $2.50.

One reason why truth is mighty and will prevail is that there is no majority rule governing its discovery. One man can find it out and if the truth be sufficiently important and the discoverer sufficiently insistent it is only a question of time before the majority enforces acceptance of that which it was incapable of discovering. Professor Ripley is the discoverer, and the vigorous and insistent reporter, of certain truths regarding the corporate conduct of business. So far, to be sure, the majority has not accepted all of his discovery nor set out to profit thereby, but he has proceeded far beyond the mere voice crying in the wilderness and has begun to draw in his train such influential adherents as the President of the United States, the New York Stock Exchange and the editorial staffs of many of our great newspapers.

The present book is a collection, with some additions, of various magazine articles which constituted the bomb-shells that Professor Ripley threw last year into the corporation camp, bomb-shells that resulted in the rejection of one proposed railroad merger, the promulgation of certain rules against non-voting stock in the New York Stock Exchange, and the addition of several vigorous paragraphs against corporation abuses in a presidential message. As starters these were very fair results for the recorded thoughts of one man, but to one reading those thoughts as collected in the book the reaction was understandable. The fact is that the mightiness of these truths will continue to prevail in increasing measure.

What Professor Ripley records is very simple: It is that the corporation, that old legal entity, has taken on new form in these states in the last decade. It has fairly usurped business. Personal business practically no longer exists. It has been superseded by a legal figment, whose funds are being more and more drawn from the people in general and whose directors are being more and more relieved of financial peril. Professor Ripley's charge is that by process of law and by the easy compliance of the stockholder, he, the stockholder, is being gradually made to bear the entire financial burden of the business and is permitted no responsibility and given none of the excess profits. To management, or rather to the financial direction, is given the privilege of playing with other people's money and the pleasure of skimming the marginal cream of profits. The non-voting stock issue, first applied to the preferred and later to certain kinds of common stock, the extending holding company with its profitable return on the closely held common stock, the obscure financial statement, the non-responsible director—all these are parts of the ma-

chinery that has grown up around the corporation to the advantage of the few and to the exclusion of the small holder, who is becoming more and more the source of the funds that make the business go.

All of this Professor Ripley enumerates in language calm enough, but obviously authoritative and copiously documented. It is illuminating and useful. It is not an attack on capitalism or on business or on finance, as some of the gentlemen engaged in those activities seem to think, but it is an exposition of evil tendency that we all should understand. The cure lies first in understanding; the processes of improvement can come later.

An Engineering Approach to Economics

INTRODUCTION TO PRODUCTION ECONOMICS—By John D. Black, Ph.D., Professor of Economics in the University of Minnesota. New York: Henry Holt & Co. Cloth; 6x9 in.; pp. 975; 79 charts and line cuts; 58 statistical tables. $4.50.

Our colleges have turned out first rate economists aplenty. They have graduated many other students who have developed into efficient executives. And everyone was satisfied until the schools of business, inaugurated during the past few years, started an inquiry to determine to what extent the so-called business man knew and practiced accepted economic principles, and just how much the theoretical economist was contributing to the efficiency of our industrial organization. It evidently developed that the results in both cases were not satisfactory because nearly every business school has revamped its economic courses, always with the idea of a more practical application in view.

This book has been developed by such a metamorphosis during the past two years in connection with the first course in economics in the School of Business at the University of Minnesota. It is described as production economics and somewhat the following line of reasoning, a happy one from the viewpoint of the engineer, was used in determining the method of approach. "A school of business by definition must concern itself mostly with production activity. If it is going to apply economics to business then it must surely stress the economics of production. But the business unit consisting of plant, equipment, labor, raw material and the entrepreneur who operates the unit and sells the product must be understood. On the other hand merely understanding the business unit without the economic principles upon which its existence and successful operation depend is almost certain to make the course a failure. Therefore, the solution is to combine the two requirements in one treatment instead of the two or more widely separated courses usually offered."

The author has effectually followed this hypothesis by stressing first the physical-economic relationships of industry and second developing them toward their relations to the principles of value and price. Indeed the age-old economic elements of land, labor and capital are hardly mentioned in their usual sense until near the middle of the book.

Only two economic principles are explained but these rather fully—the principle of comparative advantage and the principle of diminishing output. The rest of the book is developed around these principles, always stressing the physical side of production. The choice and location of enterprises, and the places of capital goods, of the earth and of the human agent in production are explained. Industrial organization and the economics of size are analyzed. Risk, exchange, and financial and marketing organizations are considered cursorily but adequately under the general plan of attack.

Although the most of the book is from the standpoint of the individual entrepreneur the finish is from a social and national standpoint considering such subjects as the dynamic nature of economic society which results in the many maladjustments of our social and economic structure, the economy of city and the economy of national "production."

While designed primarily for a college course, the subject is so well arranged in eliminating much purely economic theory that it should prove of value to engineers and practical business men generally. It more nearly approaches the much desired "bread-and-butter economics."

Publications Received

SPECIFICATION NUMBER 448 of the Federal Specifications Board covers plumbing fixtures for land use. It appears as Circular 10 of the Bureau of Standards. (15c. from Superintendent of Documents, Washington, D. C.)

A SHORT STUDY of Drainage by Means of Pumping from Wells in Salt River Valley, Arizona, constitutes Bulletin 1456 of the U. S. Department of Agriculture. (10c. from Superintendent of Documents, Washington, D. C.)

A HANDSOME PAMPHLET of 68 pp., including illustrations, reviewing Ten Years' Progress on the City Plan of St. Louis, 1916-26, has been published by the City Plan Commission of St. Louis. Besides illustrations and text, there is a folding map of the major street plan of St. Louis.

TEN DOLLARS instead of $7.50 is the price of Volume III of Guiding Principles of Public Service Regulation, reviewed in these columns Feb. 17, p. 289. Vol. I and Vol. II, noted Oct. 15, 1925, p. 644, and Jan. 21, 1926, p. 127, sell for $7.50 each. (Public Utilities Reports, Munsey Building, Washington, D. C.)

GAS-MEASURING INSTRUMENTS has been issued as Circular 309 of the Bureau of Standards. It describes various types of gas meters and contains pertinent mathematical discussion (Paper; 69 line cuts and halftones; pp. 109, including bibliography; 40c. from Superintendent of Documents, Washington, D. C.).

DETAILED DESIGNS for the application of stucco to frame buildings, together with many other practical hints, are included in Circular 311 of the Bureau of Standards entitled Stucco Investigations at the Bureau of Standards with Recommendations for Portland Cement Stucco Construction. (15c. from Superintendent of Documents, Washington, D. C.)

THE PAPER on The Use of Standpipes and Elevated Tanks to Reinforce the Distribution System During Periods of High Demand, by Nicholas S. Hill, Jr., read before the Buffalo convention of the American Water Works Association in 1926, has been reprinted for free distribution by the Chicago Price & Iron Works, Old Colony Building, Chicago, Ill.

THE UTILIZATION OF WATER POWER in the Czechoslovak Republic is the subject of a pamphlet by Josef Wolf, chief building counselor at the Ministry of Public Works, published by the Ministry of Public Works, Prague, Czechoslovakia. The pamphlet is printed in English. It gives brief descriptions of the major hydro-electric developments of the country, with numerous illustrations.

THE STANDARD SPECIFICATIONS for concrete and reinforced concrete produced in 1924 by the Joint Committee on Concrete and Reinforced Concrete have been translated by the Touring Club Italiano and published under the title Norme Americane Pel Calcestruzzo Semplice Ed Armato. The work was done under the direction of Prof. Ing. Italo Vandone, who is director of the Experimental Institute of the Club.

THIRTY PAPERS AND DISCUSSIONS on water supply and other sanitary engineering subjects are included in the Proceedings of the Fourth Annual Short School of the Texas Association of Sanitarians, held last October. Thirteen of the papers are classed under the general heading, Waste Disposal and General Sanitation. There are three paper on water supplies. (70c. in paper or $1.35 postpaid in cloth, from E. G. Eggert, secretary, Texas Association of Sanitarians, Capitol Station, Austin, Tex.)

THE VALUE TO NORTH DAKOTA of the Great Lakes-St. Lawrence deep waterway is reviewed in Bulletin 204 of the Agricultural Experiment Station, North Dakota Agricultural College, Fargo, N. D. The bulletin is a report to the North Dakota Tidewater Commission and the Greater North Dakota Association and reviews the market requirements of the state and outlines some of the advantages to be gained by opening the St. Lawrence route to deep draft vessels.

THE ST. LAWRENCE WATERWAY REPORT by the Joint Board of Engineers appointed by the governments of the United States and Canada, which was abstracted in our issue of Dec. 2, 1926, p. 906, has been printed in book form with the plates which accompanied the report. The numerous appendices of the report are not yet ready for publication and are not included. Copies of the book can be obtained from Superintendent of Documents, Washington, D. C.) ($1.32.)

MIMEOGRAPHED COPIES of a revised edition of the Illinois Model Plumbing Ordinance prepared by the Division of Sanitary Engineering, (Harry F. Ferguson, chief engineer, Springfield, Ill.) may be had on application so long as the edition lasts. The new draft supersedes one prepared in 1919. Use of this draft is not compulsory but under Sec. 5 of a legislative act of 1917 each municipality in Illinois "having a system or water supply or sewerage" must enact a plumbing ordinance or by-law, "with the advice of the State Department of Health."

WATER-SUPPLY PAPER 559, U. S. Geological Survey, summarizes a considerable amount of statistical and other information on Relations Between Quality of Water and Industrial Development in the United States. The author is W. D. Collins. Tabular comparisons are made by decades from 1849 to 1919 of the industrial activity in various states and groups of states of the Union "as indicated by values added to raw material by manufacture." These comparative figures are correlated with the hardness and softness, generally speaking, of the waters in the various states. The correlation takes into account industries located primarily with reference to population on the one hand and on the other industries dependent on quality of water. (15c. from from Superintendent of Documents, Washington, D. C.)

UNDER THE IMPOSING TITLE "Stream Pollution in the United States," followed by the still more imposing subtitle, "Monograph Relating to the Pollution and Obstruction of Navigable Streams in the United States by Sewage and Industrial Wastes," there has been printed, as House of Representatives Document No. 632, 69th Congress, 2d Session, a series of abstracts of various papers and of portions of books dealing with water pollution by sewage and industrial wastes and methods of treatment of these substances. The material so printed was prepared by George J. Schulz, Legislative Reference Service, Library of Congress. The justification, if any, for the publication of the abstract as a congressional document seems to lie in the reference to "obstruction of navigable streams" in the subtitle. The "monograph" appears, however, to contain no specific reference to such "obstruction." Where the abstractor has confined himself to the original documents, as is generally the case, the "monograph" contains little that is subject to adverse criticism, but portions of the brief introduction and briefer conclusions might mislead those uninformed as to the present status of stream pollution and means being employed for its prevention. Parts of some of the abstracts are also misleading in that they are not supplemented by even a hint that conditions described in the abstract have materially changed since the original papers were written. Thus, the abstract of Water Supply and Irrigation Paper No. 72, U. S. Geological Survey, 1902 relating to pollution of the Passaic River, is unaccompanied by any statement of the fact that in the quarter century that has elapsed since the paper was written a trunk sewer has been built from Paterson to Newark Bay which diverts from the river the greater part of the pollution described in the abstract. More might be written to indicate that it is questionable whether the publication of such document is justifiable.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

THE AMERICAN RACE PROBLEM: A Study of the American Negro—By Edward Byron Reuter, Professor of Sociology in the University of Iowa. [Crowell's Social Science Series—Edited by Seba Eldridge, University of Kansas.] New York: Thomas Y. Crowell Co. Cloth; 5x8 in.; pp. 448. $2.75, postage extra.

A comprehensive, well balanced study of the negro and the negro problem in the United States, with abundant but not oppressive statistics, some of which present data for whites as well as negroes. Among the chapter subjects are: Population, health, economic status, education, crime, and culture, the latter including art, music and literature.

DURCHLAUFENDE EISENBETONKONSTRUKTIONEN IN ELASTISCHER VERBINDUNG MIT DEN ZWISCHENSTUTZEN: (Plattenbalkendecken und Pilzdecken) Einflusslinientafeln und Zahlentafeln für die maximalen Biegungsmomente und Auflagerdrücke infolge ständiger und veränderlicher Belastung unter Berücksichtigung der Stützeneinspannung (Winklersche Zahlen) nebst Anwendungsbeispielen—By Baurat Dr.-Ing. F. Kann, Weimar. Berlin: Julius Springer. Paper; 7x10 in.; pp. 72, 47 line cuts and tables. 7.2 reischmarks in Germany.

ECONOMIC PROBLEMS OF MODERN LIFE—By S. Howard Patterson, A.M., Ph.D., and Karl W. H. Scholz, A.M., Ph.D., both Professors of Economics, Wharton School of Finance and Commerce, University of Pennsylvania. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 615. $3.

DIE GEWÖHNLICHEN UND PARTIELLEN DIFFERENZENGLEICHUNGEN DER BAUSTATIK—By Ing. Dr. Fr. Bleich, Wien, und Ing. Dr. E. Melan, O. O. Professor A. D. Techn. Hochschule in Wien. Berlin and Wien: Julius Springer. Cloth; 6x9 in.; pp. 348; 74 line cuts. Bound, 28.5 reichsmarks in Germany.

DER GRUNDBAU—Von Dr.-Ing. e.h. Brennecke, Marine-Hafenbaudirektor a. D., Geheimen Admiralitätsrat. In vierter Auflage—Neubearbeitet und herausgegeben von Dr.-Ing. Erich Lohmeyer, Ministerialrät in Berlin. Erster Band: Baugrund, Baustoffe, Pfahle und Spundwände, Baugrube. Berlin: Wilhelm Ernst & Sohn. Paper; 6x9 in.; pp. 261; 244 line cuts and halftones. Paper, 19.2, cloth, 21 reichsmarks in Germany.

HISTORY OF THE ELEVENTH ENGINEERS—By V. T. Boughton, Assistant Editor, *Engineering News-Record*, formerly Adjutant, 11th Engineers, U. S. Army. New York: Trustees, Eleventh Engineers Fund, 84 Pine St. Cloth; 6x9 in.; pp. 540; 265 halftones and line cuts, 7 plates. $3 to limited sale outside of regiment.

HOLZ IM HOCHBAU EIN NEUZEITLICHES HILFSBUCH FÜR DEN ENTWURF, DIE BERECHNUNG UND AUSFUHRUNG ZIMMERMANNS- UND INGENIEURMASSIGER HOLZWERKE IM HOCHBAU—By Ing. Hugo Bronneck, Behordl, Autor, Zivilingenieur für das Bauwesen. Wien: Julius Springer. Paper; 6x9 in.; pp. 388; 415 halftones and line cuts, numerous tables. 22.2 reichsmarks in Germany.

INDUSTRIAL AND COMMERCIAL SOUTH AMERICA—By Annie S. Peck, A.M., F.R.G.S., Author of "A Search for the Apex of America," "The South American Tour," "A Descriptive Guide," etc. New and Revised Edition. New York: Thomas Y. Crowell Co. Cloth; 6x9 in.; pp. 489. $3.50.

American manufacturers interested in the South American market should find in this revised edition of a work first published in 1912, a useful reference text. It considers not only each country but each state and the important cities in it. An outline of the included information for each state follows: (1) The state as a whole, (2) physical characteristics, (3) the capital, the states and territories, chief cities, (4) ports and transportation, (5) resources and industries. In the appendix are given information on postal regulations, cable facilities, banking, steamship lines, publications and a bibliography of books.

JAHRBUCH DER DEUTSCHEN GESELLSCHAFT FÜR BAUINGENIEURWESEN: 1926. Berlin: G.M.B.H. Paper; 5x8 in.; pp. 230; 31 halftones and linecuts.

Second annual of society named. Besides list of members and classified bibliography reviews, among other subjects, cement, concrete, airports and municipal underground construction. Contains tabular description of 33 hydro-electric developments.

MAGNETIC DECLINATION IN THE UNITED STATES IN 1925—By Daniel L. Hazard, Assistant Chief, Division of Terrestrial Magnetism and Seismology. [Special Publication No. 126, U. S. Coast & Geodetic Survey.] Paper; 6x9 in.; pp. 38; large folding map. 10c. from Superintendent of Documents, Washington, D. C.

SMOKE-ABATEMENT INVESTIGATION AT SALT LAKE CITY, UTAH—By Osborn Monnett, G. St. J. Perrott, and H. W. Clark. [Bulletin 254, Bureau of Mines.] Paper; 6x9 in.; pp. 98; 44 tables; 24 halftones and line cuts. 30c. from Superintendent of Documents, Washington, D. C.

Gives results of the studies made in 1920, smoke abatement ordinance subsequently adopted, and results into 1926, including marked increase in smoke production after city stopped abatement work, Jan. 1, 1927.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Design of the Roxy Theater Balcony

Sir—In the article describing the construction of the Roxy Theater balcony, printed in *Engineering News-Record* of Feb. 17, 1927, p. 266, the writer inadvertently omitted mention of H. Robbins Burroughs, consulting engineer, who was retained by Levering & Garrigues Co. in making the design for the steelwork for that theater, which design was included in their contract.

A. T. NORTH,
American Institute of Steel Construction.

New York, N. Y.,
March 5, 1927.

Testing Sand for Concrete Aggregate

Sir—I read with a good deal of interest Mr. Bennett's remarks in the Feb. 17 issue of *Engineering News-Record*, p. 291, in regard to testing of sand for concrete aggregate.

He gives the impression that the use of the same consistency for both the standard Ottawa sand mortar and the local sand mortar is something new. The fact is that the A.S.T.M. specification to which he refers, which is C-33-23 T, definitely states as follows:

> ". . . shall show a tensile or compressive strength at the age of 7 and 28 days not less than that of 1:3 standard Ottawa sand mortar of the *same consistency* made with the same cement."

The specification unfortunately does not state, however, how to determine that the consistency of the local sand mortar is the same as that of the standard sand mortar. Our organization uses for this purpose the small flow table.

Mr. Bennett's suggestion that the fineness modulus of the sand be made equal to the Ottawa sand for the mortar test may be of value to determine the characteristics of the large particles of the sand, but certainly is of no value in regard to the sand itself, since the most objectionable part of the sand quite often is the very fine grains.

There can be no question of the value of the compression test of concrete made with the local sand as a measure of the usability of the sand. The test is more expensive, however, than the briquet test, and for that reason is probably not used nearly as much at it should be.

MILES N. CLAIR,
Construction Engineer, The Thompson & Lichtner Co., Inc.

Boston, Mass.,
Feb. 28, 1927.

Street Car Tracks Near the Curb

Sir—Referring to Mr. Foote's letter, in *Engineering News-Record*, Jan. 27, p. 166, relative to locating street car tracks near the curbs of streets, the writer wishes to advise strongly against the idea.

An example of such a location will be found upon Elmwood Ave., Providence, R. I., and while the location might be satisfactory in Berkeley, Calif., or vicinity, it has its disadvantages in the East, particularly during the winter season.

During and after a fall of rain, or when snow is melting, the spaces adjacent to the tracks fill with water, carrying a high percentage of solids in suspension, and when a car passes (they run at no mean rate of speed) the result is a spray of liquid over the sidewalk to the great annoyance of unwary pedestrians.

Further, when the sidewalks are covered with sleet a slip may throw a pedestrian in front of, or against, a passing car. The writer witnessed the fall of a woman under just such conditions, who, while trying to make her way to the inside of the walk because she saw a car nearing her, lost her footing and when she struck the walk one foot was across the nearest rail, she being so shocked by her fall as to be unable to move. Only the alertness of the motorman saved a bad accident.

Another bad feature is found in the danger to children playing on the sidewalk. There is plenty of risk in such a case when the cars are in the middle of the street but it is greatly enhanced when they run near the curb, especially in congested districts where there is no place for the children to gather except upon the sidewalks in front of their homes.

C. M. DURGIN.

Providence, R. I.,
Feb. 7, 1927.

Determining Timing at Traffic Lights

Sir—The writer was very much interested to note the arrangement of the slide rule chart for determining timing of traffic lights as published in your issue of Feb. 10, p. 231. It occurs to me to send you a copy of a little drawing that I made up some time ago to accomplish the same purpose and suggest that a diagram similar to mine might be made up which would be useful for all cases, whereas your slide rule requires cutting special slides, as I understand it, to represent the length of each block between streets.

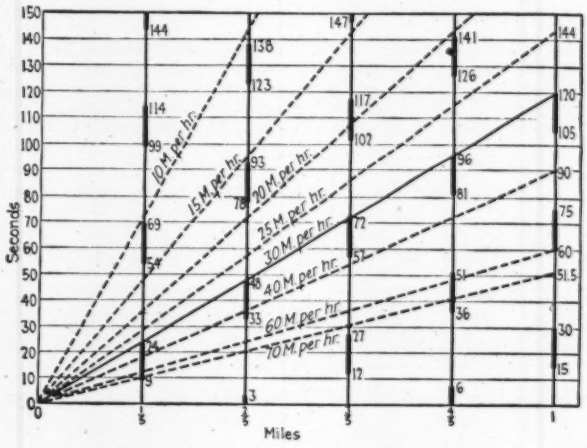


CHART FOR TIMING TRAFFIC LIGHTS

In the accompanying drawing the heavy vertical lines represent the red lights and the narrower ones the green. By marking out the length of the blocks horizontally the vertical red and green sections can then be so located with reference to any given speed desired in miles per hour along any given highway.

This particular drawing was made as an illustration to show a maximum permissible speed of 30 m.p.h. in a section just outside the thickly settled portion of a city.

You will note that with this arrangement there is practically a clear passage also at a speed of 25 m.p.h. under a progressive system of timing the lights. With such an arrangement there is always some interference with slower speeds, but of course this cannot be avoided and is to be expected. But this interference is of no importance as those traveling at slow speed get along all right as their delays are only a few seconds at infrequent intervals. You will note that the 15-mile speed shows a practically clear way for a considerable distance.

L. H. KUNHARDT,
Vice-President, Boston Manufacturers' Mutual Fire Insurance Co.

Boston, Mass.,
Feb. 17, 1927.

Indian Irrigation Dams

Sir—In the review of "Irrigation in India" in *Engineering News-Record* of Nov. 18, 1926, p. 833, p. 926, the statement as to the dams that "both of these structures are for hydro-electric power and irrigation purposes" is somewhat misleading. There is a small hydro-electric plant at Bhatgar at present, but this was installed for running machinery during construction only. At Bhandardara there is no hydro-electric plant nor is it proposed to install any.

C. H. BOWERS,
Superintending Engineer, Deccan Irrigation Circle.

Poona, India,
Jan. 3, 1927.

[The error seems to have been due to a misunderstanding of some earlier reports. The Bhatgar dam was described in *Engineering News-Record* of Aug. 14, 1924, p. 268.—EDITOR.]

News of the Week

Current Events in the Civil Engineering and Contracting Fields

A.R.E.A. Annual Meeting Breaks Records

Great Increase in Attendance—Review Research Work—Many Reports Discuss Economics

Again the annual meeting of the American Railway Engineering Association broke all records in attendance, the total registration at the 28th meeting, held in Chicago on March 8 to 10 being 1,271 as against 1,030 at the 1926 meeting. This included 925 members and 346 guests, as compared with 831 and 199 respectively in 1926. At the annual dinner the speakers were S. E. Winslow, chairman of the U. S. Board of Mediation and Conciliation, and W. G. Bierd, receiver (and formerly president) of the Chicago & Alton R.R. After the three-day meeting there was an inspection trip over the newly electrified Chicago terminal lines of the Illinois Central R.R.

PRESIDENT'S ADDRESS

Economic aspects of railway track, together with the relation of locomotive counterbalancing and the three-cylinder locomotive to stresses in rails and track structure, were the main features noted in the brief presidential address of C. F. W. Felt, chief engineer of the Santa Fe Ry. System. He outlined the research work which is being continued on a number of subjects, and he predicted that in future the committee reports will be presented still further in advance of the meetings, owing to the plan of having the committees continuous instead of being reorganized annually. A membership of 2,511 on March 1, was noted in the secretary's report, being a net increase of 189 during the year. There is a constantly increasing demand for the association's various specifications, indicating a wider appreciation of their value. To assist the research work, the American Railway Association has granted $2,000 towards the experiments on devices for detecting transverse fissures in rails, and $1,500 for those on the bearing value of the rolling surfaces of rolling bascule bridges. The financial statement showed a balance of $53,743, as compared with $55,614 in 1926.

Reports from 25 of the 26 committees had been printed in advance, the committee on Clearances being the only exception. These aggregated about 1,150 pages, but much of the material consisted of progress reports or general information not calling for discussion. Real discussion developed in only a few cases. One committee was censured for neglecting the subjects assigned to it and undertaking to report on the manner of conducting the convention proceedings. However, at the close of the meeting it was voted to refer the suggestions to the Board of Direction.

A gold medal was presented to L. A. Downs (Central of Georgia R.R.) as an appreciation of his many years of service on the Board of Direction, from which he now retires.

The president elected for 1927 is Daniel J. Brumley, chief engineer of Chicago Terminal Improvements of the Illinois Central R.R.; W. D. Faucette, chief engineer of the Seaboard Air Line Ry., becomes first vice-president, and Louis Yager, assistant chief engineer of the Northern Pacific Ry., was elected as second vice-president, to succeed Mr. Faucette. C. H. Fritch was re-elected as secretary.

Road Bond Issue of $30,000,000 Authorized by N. C. Legislature

The North Carolina General Assembly has authorized the issuance of $30,000,000 worth of bonds for continuation of the state's highway program.

The Senate passed a House bill authorizing the issue without opposition, after voting down amendments that would have cut the issue to $25,000,000 and one that would prevent counties loaning money or giving bonds to the State Highway Commission.

This authorization brings the total road bond issues authorized by the North Carolina General Assembly since the state's road building program started to $115,000,000.

Engineering Fifty Years Ago

From *Engineering News*, March 17, 1877

FROM the annual report for 1876, of D. Farrand Henry, chief engineer of the Detroit, Michigan, water-works, we glean a few facts of interest. Total pipeage of the city, 187½ miles, of which 94⅝ miles are iron pipe and 92 and ⅝ miles wooden logs. The present pumps and mains will supply about 22,000,000 gal. in 24 hours, but if a little time is taken for cleaning and rest as at present, not over 20,000,000 gal. a day could be furnished.

Syracuse Changes Degree Awards

Effective in June, 1927, the college of applied science of Syracuse University will grant the degrees of Bachelor of Science in civil, electrical, mechanical, chemical and administrative engineering, and will discontinue the professional degrees of civil engineer, electrical and mechanical engineer.

The recommendation for this change was made by the college faculty and approved at the last meeting of the New York State Board of Regents.

New York State at Odds Over Water Power

Governor and Legislature Disagree Over Method of Developing State's Power Sites

Failure of the state legislative leaders and the governor of New York to agree upon a plan for water-power development has resulted in the submission to the legislature of bills embodying the views of the opposing factions, the governor submitting a bill for the establishment of a power authority in which should be vested the state's rights in all power sites and which should be required to report to the legislature by next January, whether the plan of developing power by a power authority is a feasible proposition or whether the work should be turned over to private capital; and the bill of the legislative leaders which proposes setting up a commission to investigate the whole water-power situation and to advise the legislature by January of next year whether the work should be undertaken by the state or by private capital under state lease.

The chief difference between the two points of view is that the majority leaders in the legislature are opposed to setting up a power authority appointed by the governor until the whole matter has been considered by an impartial commission appointed jointly by the governor and the legislature because the legislative leaders feel that once the power authority is established, it would be inclined to favor carrying out power development under its own auspices and so would not render an impartial report to the legislature as to whether it should do the work or private capital should be called in.

GOVERNOR'S PROPOSAL

The power authority as proposed by the governor "shall have full power to develop these (the state's) resources for the generation of hydro-electric energy and for the sale of such energy in the interests of all the people of the state; and to issue bonds or securities for financing such developments, which bonds or securities and the property owned by said authority shall be declared to be instrumentalities of the state and exempt from state tax; such bonds and securities shall be secured by the revenues to be derived from operation, without involving any pledge of the state's credit."

The governor, in opposing the appointment of a commission, believes that no good purpose will be served in further postponing definite action while waiting for the report of a commission which, no matter what report is brought in, will not change the present situation.

Such a commission, he says, would provide means of a hearing for everyone with ideas on the subject.

Engineers Named for Bay Bridge Study at San Francisco

In accordance with the request of the San Francisco board of supervisors, the presidents of four universities in the San Francisco Bay region have submitted a list of thirteen engineers competent to make a study of all phases of the problem of bridging the bay from the city of San Francisco to the Alameda County shore and selecting the best site for such a bridge. Previous reference to this plan appeared in *Engineering News-Record*, March 3, p. 374.

The thirteen names include five engineers from the San Francisco Bay region and eight from outside the state. While it is desirable on a commission of three engineers to have one man with a knowledge of local conditions, the letter of transmittal pointed out, it was strongly recommended that not more than one local engineer be selected.

The names submitted were as follows: Bion J. Arnold, Charles F. Loweth, George H. Pegram, Robert Ridgway, John F. Stevens, George F. Swain, Arthur N. Talbot, William J. Wilgus, Henry D. Dewell, John D. Galloway, L. H. Nishkian, Christopher H. Snyder, Charles B. Wing.

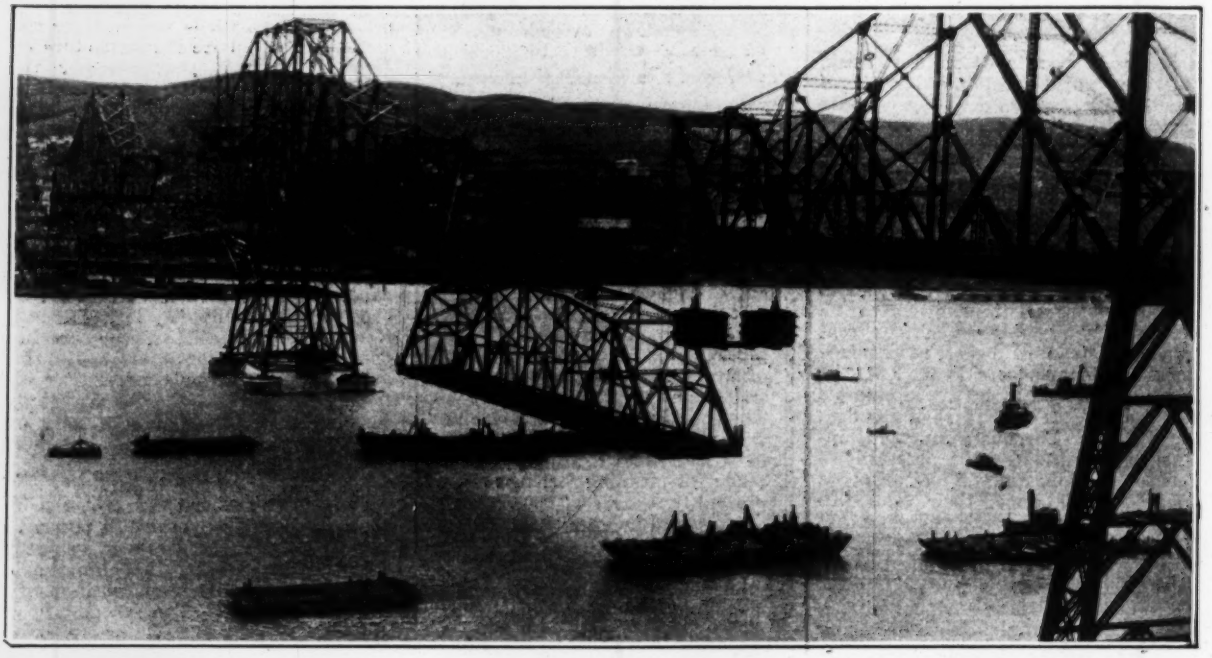
Power Possibilities Revive Old Canal Project

Opposition to the renewal of the charter of the Montreal, Ottawa and Georgian Bay Canal Co. is developing in Canadian Parliamentary circles. The charter has been renewed from time to time during the last 33 years, but companies who are interested in the several important water-power sites on the Ottawa, Mattawa and French rivers, including the site at Carillon, on the Ottawa River, are strongly opposing the company's present application for a renewal of charter, on the ground that it would result in setting up a hydro-electric monopoly along the route of the proposed canal. The company has announced that it is prepared to spend $280,000,000 in the next ten years, and that $92,000,000 has already been provided.

A.S.T.M. to Convene in French Lick, June 20-24

The 30th annual meeting of the American Society for Testing Materials will be held at French Lick Springs Hotel, French Lick, Ind., June 20-24. The first day will be devoted to committee meetings and the first session of the annual meeting will be held in the morning or afternoon of June 21. The closing session will be Friday evening, June 24. In order to accommodate the number of items on the program, a number of simultaneous sessions will be necessary. The provisional program for the meeting will be mailed to members late in April. Details of the program are now being developed by the committee on Papers and Publications. Papers so far accepted include those on machine testing and on the testing of thin sheet metals. There will also be a symposium on field control of the quality of concrete, and a number of papers on instruments and the methods of tests, including the spectrograph as a laboratory tool.

Counterweights Lift Suspended Span of Carquinez Bridge



ON MARCH 3 the first of two 430-ft. suspended spans in the toll bridge across Carquinez Strait, Calif., was successfully raised to place in the structure, 138 ft. above water level. Exclusive of approach viaduct the bridge will have a total length of 3,350 ft. including two 1,100-ft. spans, each made up of a 430-ft. central suspended span and two cantilever arms. The bridge is now complete except for the second suspended span and a 7-in. concrete roadway. The second suspended span is to be raised about March 17. An article on the design of the bridge appeared in *Engineering News-Record*, Sept. 24, 1925, p. 504.

The two suspended spans were erected on falsework over the water near shore. When the time came for placing the first span, barges were floated under either end at low tide, a 500-ton jack lifted each corner, transferring the weight from falsework to the barges and the span was then floated out under the cantilever arms. Cables from the ends of the cantilever arms were attached to the four corners of the span as it floated on barges. Two of these cables, 2¼ in. in diameter, were attached at each corner of the span, were passed thence over sheaves on the cantilever arm and connected by an equalizing device to the counterweight. The suspended span weighed 600 tons.

The counterweights, of which there were four, were slung from the ends of the cantilever arms at bridge floor level until the span was ready for raising. Being slightly heavier than the span the counterweights did the lifting when the tackle by which they were suspended was slowly slacked off. As the counterweights were lowered the suspended span was lifted. The span was raised to place in 50 minutes and the 12-in. pins were then slipped through the suspended eyebars.

The work was done by the American Bridge Co.

Am. Soc. C. E. Admits Woman to Corporate Membership

For the first time in its seventy-five years of existence the American Society of Civil Engineers has elected a woman to corporate membership. Elsie Eaves, a graduate of the University of Colorado (1920) with the degree of B.S. in civil engineering and with engineering experience which has included service with the U. S. Bureau of Public Roads, the Denver & Rio Grande R.R., the Colorado State Highway Department and the consulting engineering office of H. S. Crocker of Denver, became an associate member of the society March 14. Since March, 1926, Miss Eaves has been in New York engaged in market survey work with *Engineering News-Record* and *Successful Construction Methods*, two of the McGraw-Hill engineering and industrial publications. She is a native of Denver, Colorado.

Since it was founded in 1852 the American Society of Civil Engineers has admitted three women to the grade of "junior member." Miss Eaves, however, is the first woman to be admitted to the full privileges of corporate membership.

Reading Co. Denied Leasing of Lehigh & New England

The application of The Reading Co. for authority to lease the Lehigh & New England Railroad Co. has been denied by the Interstate Commerce Commission.

The Lehigh & New England, a small road with about 130 miles of main line, is an important connecting line in eastern trunk-line territory. It extends from the anthracite coal region of Pennsylvania across New Jersey into New York with southern connections with the Reading, D. L. & W., Lehigh Valley, Jersey Central and the Pennsylvania and at its northeastern end with the Erie, New York, Ontario & Western, and with the New York, New Haven & Hartford through the Central New England by way of the Poughkeepsie bridge. The Reading proposed to acquire the railroad in order to provide itself with a better route to New England by avoiding the congestion at New York, also to open a new through route to the Baltimore & Ohio and Western Maryland for bituminous coal to New England.

The Reading proposed to pay a net cash rental of $1,069,000 per year or $330,000 more than the average net annual income for the past ten years. The Reading estimated the annual saving through consolidation to be $477,000.

The lease was favored before the commission by the Baltimore & Ohio and the Western Maryland and was opposed by the New Haven and the Pennsylvania, the latter on the ground that as its principal competitor the B. & O. and the New York Central each owned a quarter interest in the Reading.

In considering the lease the commission said that the sharp rivalry between the great systems for the control of the Lehigh & New England emphasizes the evidence of its importance in the transportation system, that to lease the Lehigh & New England to the Reading would make it possible for the latter to exercise control over both it and the Lehigh & Hudson, a somewhat similar line. Also, the commission drew attention to Professor Ripley's proposal in his plan for consolidation of the railroads of the country, that this road be assigned to the New Haven or kept as an open bridge route. Consequently, as the Lehigh & New England is not a financially weak carrier needing control by a stronger carrier, the commission denied the Reading permission to lease the railroad.

Daniel J. Brumley Elected President of A.R.E.A.

Chief Engineer of Chicago Terminal Improvements and Electrification of Illinois Central R.R.

The newly elected president of the American Railway Engineering Association, Daniel J. Brumley, of Chicago, is a graduate of the track and maintenance-of-way department of railway engineering. He succeeds C. F. W. Felt, chief engineer of the Atchison, Topeka & Santa Fe Ry. System.

Mr. Brumley was born March 19, 1865, near Leipsic, Ohio. After an academic course at Ohio Northern University, Ada, Ohio, he graduated from Ohio State University in June, 1895, and in the same year began his railway engineering career as an assistant section foreman on the Louisville & Nashville R.R., at Evansville, Ind. During part of 1896 he was assistant engineer for the Columbus & Hocking Coal & Iron Co., New Straitsville, Ohio, but in December he returned to the Louisville & Nashville R.R. as section foreman, thence rising to rodman and to assistant engineer in 1898. In 1907 he went to the Mexican National R.R. as engineer maintenance-of-way, but again returned to the Louisville & Nashville, where he remained as road-master for three years, and was then division engineer for the Indianapolis & Southern Ry. from October 1904 to March, 1905. At this latter date he became principal assistant engineer for the Illinois Central R.R. and Yazoo & Mississippi Valley R.R., and was promoted successively to engineer of construction of these roads, May, 1910; engineer maintenance-of-way, April, 1913; assistant chief engineer, November, 1913; valuation engineer, April, 1914, and chief corporate engineer in October, 1918. Then in 1920, as the great project got under way for rebuilding, improving and electrifying the Chicago end of the line and providing new main-line and suburban terminal stations, Mr. Brumley was made chief engineer of Chicago Terminal Improvements of the Illinois Central R.R., with a separate organization and staff, independent of the general engineering department.

Besides membership in the American Railway Engineering Association, Mr. Brumley is a member of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the Western Society of Engineers and the Chicago Association of Commerce. He has been active in the work of the American Railway Engineering Association, having served on the Electricity committee for 15 years, the Roadway committee for three years and the Records and Accounts committee for one year.

New A.R.E.A. President

DANIEL J. BRUMLEY

International Body Proposed to Develop St. Lawrence

Secretary Hoover, speaking in New Haven, Conn., on March 12, on the subject of the St. Lawrence shipway, suggested that many of the problems in connection with the development of the St. Lawrence River for navigation and power could be simplified if some sort of a joint governmental body was formed whose personnel would be chosen by the two governments for the purpose of carrying on the work and whose bond would be mutually guaranteed by the two governments. Secretary Hoover does not believe that there are any problems in connection with this work which are different from those which have been arranged for satisfactorily between the two governments in the past, nor does he believe either government needs to surrender any of its sovereign rights in order to finance the construction or operate the canals.

Headings Meet in Duboce Tunnel in San Francisco

On March 11 the 6x7-ft. top headings met in the Duboce tunnel which is being constructed by the city of San Francisco to provide a direct street-car route from the business district to the Sunset residential section. The tunnel will be 4,230 ft. long, and is designed for two street-car tracks, the same as the existing Twin Peaks tunnel. It is being built by contract at a total cost, including rights-of-way, etc., of $1,652,000. The construction contract was for $1,250,000.

Large Hydro Plant Proposed for South Carolina

The Lexington Water Power Co., of Columbia, S. C., is making plans for an early start upon the construction of a large hydro-electric power plant on the Saluda River in South Carolina, about 10 miles west of Columbia, according to an announcement made by the General Gas & Electric Corporation. Exact details of the project are not available, but it is understood that the company proposes building an earth-fill dam 8,000 ft. long and 188 ft. high, which will create a storage reservoir 30 miles long and 14 miles wide at the widest point. The ultimate installation of power equipment is stated to be 200,000 hp. and the estimated cost of the completed project, $20,000,000.

Last summer the Federal Power Commission issued a preliminary permit to the Lexington Water Power Co. covering this site. The plans then called for a dam 93 ft. high and a power house with four 12,000-hp. units. No application for a license covering the site has yet been made.

Construction is to be carried on by the W. S. Barstow Management Association, Inc. Murray & Flood, engineers, New York, are engineers for the project.

Automobile Interests Urge Care in Toll-Bridge Financing

A meeting last week of the directors of the National Automobile Chamber of Commerce passed a resolution recommending limitation of the toll-bridge principle as far as possible and recommending that where it is necessary financing be public rather than private. If neither of these contingencies is possible, the chamber recommends that provision should be made that the property shall revert to the state after the capital has been amortized with a fair return on the investment.

The text of the resolution on the subject is as follows:

Whereas: The construction and maintenance of highways is a public task undertaken through funds contributed by tax-paying groups and particularly by the motor users of the country, and

Whereas: These funds are not always sufficient to permit of immediate construction of bridges made necessary by the growth in motor-vehicle traffic.

Resolved: That wherever toll bridges become necessary, these should be financed from public bond issues and should remain as toll bridges only until such time as the costs of the improvement have been defrayed, and should forever after be free to all, and

Be It Further Resolved: That if public funds cannot be made available, the right to build and operate toll bridges should be granted to private parties only after a most careful and searching inquiry and with definite understanding that such franchises shall be limited in nature and shall continue only for such periods as will provide reasonable return. Thereafter bridges shall become public property and be free to all. In all cases the construction and operation of such bridges should be under the control of state highway departments whose duty it shall be to see that the public interest shall be fully safeguarded.

Washington Notes

DEFERMENT of the construction period for two years has been allowed the Washington Irrigation and Development Co. in connection with its license for the development of Priest Rapids on the Columbia River. It was pointed out at a meeting of the Federal Power Commission that the applicant has expended considerable sums on the project in an effort to develop a market for the power. The extension in time is asked so that these studies may be continued. The license prescribed that the construction work is to commence on or before March 5, 1927 and to be completed to a capacity of 320,000 hp. on or before Dec. 31, 1931. These limits are extended for two years in the amendment which the commission just has allowed.

AN application has been made to the Federal Power Commission by R. H. Woods, of Lordsburg, New Mexico, for a preliminary permit covering a project on the Gila River in Hidalgo and Grant Counties, New Mexico. The plan contemplates the construction of five power houses and storage reservoirs. This would make available 50,000 hp., it is estimated.

AFTER successfully running the blockade in the Senate the amendment to the water power act, which would have allowed the commission to hire its own personnel, failed of passage in the House. The Interstate and Foreign Commerce Committee considered the resolution during the closing days of the session, but did not act upon it.

THE Northern Connecticut Power Co., of Thompsonville, Conn., has applied to the Federal Power Commission for a license covering a project on the Connecticut River in Hartford County, Conn., and Hampden County, Massachusetts.

The applicant proposes to construct a dam 1,150 ft. long in the east channel and a dam 500 ft. long in the west channel of the river. The former dam will be 17 ft. high and the latter 23 ft. high. It is proposed to install ultimately six units of 8,300 hp. each. The application covers the same project as that filed by the Connecticut River Co., but the preliminary permit issued to that company has expired. In the meantime the Gonnecticut River Co. has been absorbed by the Northern Connecticut Power Co.

ONE of the last bills passed by the Senate before adjournment was the resolution directing the Federal Power Commission to issue no permits or licenses under the water power act, "Upon or affecting the Colorado River or any of its tributaries in the states of Colorado, Wyoming, Utah, New Mexico, Nevada, Arizona and California, until and unless the Colorado River Compact, signed at Santa Fe, N. M., Nov. 24, 1922, has been approved by the Congress of the United States, or in the event that the compact is not sooner approved, until March 5, 1929."

The resolution had support in both the upper and lower basins of the Colorado. The upper states were anxious to prevent the possibility of establishing prior rights in the lower states and there was also the desire to make certain that no rights were acquired which would pave the way for the construction of the Boulder dam.

Long Channel Span for New Ohio Bridge: C. & O. Ry.

Permission for the reconstruction of the Ohio River bridge of the Chesapeake & Ohio Ry. between Cincinnati, Ohio, and Covington, Ky., as granted recently by the War Department, calls for a channel span of 675 ft. c. to c. of piers in place of the present 550-ft. span which gives a 522-ft. waterway. It was intended by the railway to duplicate the present spans in a new double-track superstructure, with lengthened piers, but navigation interests requested an increased channel opening and objected to the proposed increase in length of the channel piers. General Jadwin, chief of engineers, U. S. Army, pointed out that while a clear waterway of 521 ft. is considered reasonable on a straight stretch of river, it is not sufficient for safe navigation at bends, due to the flanking movement of long tows. This bridge, he explained, is located at one of the worst bends on the river and at a point where conditions are aggravated by the current setting toward the Kentucky shore and by smoke from a great industrial district. On this ground the objections of the railroad to a change in span lengths were overruled. The modified plans provide for an extension of the present Kentucky pier 40 ft. downstream and the construction of a new pier 125 ft. shoreward from the present Ohio pier.

Three Incinerators to Be Built for Birmingham, Ala.

The city of Birmingham, Alabama, has let contract for three garbage incinerator plants to serve as many districts of the city. There will be a plant of 180 tons capacity for the older section of Birmingham; one of 90 tons for the Ensley section and one of 60 tons for the North Birmingham section. When the capacity of the larger plant is increased, the intention is to install a fourth incinerator for the East Lake section of the city. At each plant the incoming material will be dumped into pits from which a grab bucket working from an overhead crane will lift the refuse for discharging to the furnaces.

The contract has been let to the C. O. Bartlett & Snow Co., Cleveland, Ohio, at $352,800 for complete plants in operation, including both design and construction of foundation, buildings, furnaces, flues and chimneys complete. A. J. Hawkins is city engineer.

Engineering Societies

Calendar

Annual Meetings

ASSOCIATED PENNSYLVANIA CONSTRUCTORS, Harrisburg, Pa.; Annual Meeting, Harrisburg, March 24, afternoon, and March 25, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The San Francisco Section of the American Society of Civil Engineers on Mar. 5 made an inspection trip to the Sunset or Duboce tunnel which is being built under contract for the city of San Francisco and is about half completed. The tunnel is to provide a more convenient route from the business district to the residential section and is designed for a double-track electric railway line.

The Engineering Section, Northwestern Electric Light & Power Association, held its fourth general meeting in Portland, Ore., March 10 and 11 Papers presented at this meeting before the hydraulic power committee are as follows: "Some Recent Developments in High-Head Turbine Design," by Ely C. Hutchinson, president, Pelton Water Wheel Co.; "The Co-ordination of Power and Irrigation Interests," by J. C. Stevens, consulting engineer, Portland, Ore.; "Silt Deposits and Methods of Elimination," by J. H. Siegfried, Pacific Power & Light Co. Demonstration of a new tunnel cross-section measuring device was also made by D. W. Proebstel, Portland Electric Power Co.

The Canadian Section of the American Water Works Association at its seventh convention held at Ottawa, Ont., beginning March 2, elected the following officers for 1927-28: Chairman, D. McL. Hanna, service superintendent, Windsor, Ont.; vice-chairman, J. O. Meadows, consulting sanitary engineer, Montreal; secretary, A. V. Sanderson, superintendent of filtration, Toronto, Ont. The 1928 convention will be held at London, Ont.

Florida Engineering Society will hold its 11th annual meeting March 21 and 22 at Clermont, Florida. The state chapter, A.A.E., and state section, A.S.M.E., will meet simultaneously at the same place.

Personal Notes

LOUIS E. COTÉ, acting chief engineer of the Department of Marine and Fisheries, Ottawa, Canada, since the retirement of B. H. FRASER as chief engineer about a year ago, has now been appointed chief engineer.

A. E. DYATT, vice-president of the Kansas Engineering Co., which has its headquarters at Topeka, Kan., is in charge of the office which the company has opened in Amarillo, Texas, located in the Askew Building in that city. The company expects to handle federal-aid plan work in Texas along the same lines as those under which it has operated in Kansas. It will also handle a general engineering business including sewers, water-works and paving.

GEORGE P. QUIGLEY, formerly superintendent of construction for H. L. Stevens & Co., New York, N. Y., is now associated with Benjamin J. Rymon, of Phillipsburg, N. J., and is in charge of construction at the new Phillipsburg high school.

CHARLES A. NAGEL has been admitted to membership in the firm of Green-Mullenbruck & Nagel, Inc., contractors, 105 W. Monroe St., Chicago, Ill., the name of the firm being changed as here noted, to indicate that fact.

F. M. PLAKE, who for the past four years has been assistant to the chief engineer of the Missouri Public Service Commission, has been appointed chief engineer, succeeding JAMES L. HARROP, resigned. Prior to his connection with the Missouri commission, Mr. Plake was for eight years senior structural engineer in Missouri for the Interstate Commerce Commission. His new position includes valuation and appraisal work.

DR. G. DE THIERRY, head of the Department of Hydraulic Engineering at Charlottenburg, Germany, and one of the foremost hydraulic consultants of Europe, is to come to the United States April 2. After a brief stay in New York he will proceed to Boston, where he expects to begin a short course of lectures on the utility of hydraulic laboratories at Massachusetts Institute of Technology. After this, he will take a brief tour to points of engineering interest in the northeastern quarter of the United States, probably visiting Niagara Falls, Washington and a few of the leading colleges.

MONTGOMERY B. CASE, who for several years past was senior resident engineer in charge of construction of the Philadelphia-Camden bridge for the Delaware River Bridge Joint Commission, has been appointed engineer of construction, effective April 1, for the new long-span suspension bridge that is to be built over the Hudson River from New York City to New Jersey, known as the Fort Lee bridge. Mr. Case has been engineer of construction on a number of other large bridges, including the Celilo bridge over the Columbia River, the Cherry St. bridge at Toledo, Ohio, and the large cantilever bridge over the Mississippi River at Memphis, Tenn., known as the Harahan bridge.

S. FRANK NOLAN, formerly superintendent of maintenance of the Providence, R. I., water works, has been appointed city engineer of Providence. Mr. Nolan began his career in the same office which he will now occupy as a rodman, working for three years in the sewer department. Later he was promoted to the park department, and given charge of the construction of the artificial lakes in Roger Williams Park. In 1917 he entered the service and was commander of Forts Strong and Warren. In 1919 he was sent to Italy with a force of engineers to make an estimate of the amount of damage done to railways, roads and canals and upon his return gave the report to the Peace Commission. He returned to Providence in 1920 and became superintendent of maintenance.

S. H. CLELLAND, for some years assistant engineer of Division 4 of the Missouri State Highway Department and stationed at Kansas City, has been promoted to division engineer for Division 10, which includes thirteen counties, and will have headquarters at Sikeston, Mo., succeeding in this work Frank B. Newton, resigned.

FRANK B. NEWTON, formerly engineer of Division 10 of the Missouri State Highway Department, has accepted a position with the Selden-Breck Construction Co., of St. Louis, Mo., and will go to Argentine Republic to make estimates on construction work there in which this company is interested.

Obituary

MRS. ROBERT RIDGWAY, the wife of Robert Ridgway, chief engineer of the Board of Transportation of New York City and past-president of the American Society of Civil Engineers, died suddenly on March 12 while out for a walk near her home in New York City. Mrs. Ridgway was Miss Lily A. Littell and was married to Mr. Ridgway in 1888.

J. ST. GEORGE BOSWELL, consulting engineer for the Quebec Harbor Commission, died on March 3 at Quebec. He obtained his degree of Bachelor of Science at McGill University in 1874. He was one of the engineers engaged in the laying out of Mount Royal Park, Montreal, and in 1877 joined the staff of the Quebec Harbor Commission of which he afterwards became chief engineer. On his retirement he was appointed consulting engineer for the same commission.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Track Machines Numerous at Chicago Railway Show

Railway track appliances and track tools formed the majority of nearly 200 exhibits at the Railway Appliances Exhibition held at Chicago, in connection with the recent convention of the American Railway Engineering Association. Signals, crossing gates and motor section cars were less numerous than usual.

Stationary and traveling devices for oiling track were special features. The former, for lubricating rails on curves and exhibited by the Maintenance Equipment Co., Chicago, consisted of a 10-ft. oil trough bolted to the rail, in advance of the high side of the curve, and having disks which engage the gage side of wheel flanges. These disks are revolved by mechanism actuated through the wave motion of the rail. For oiling rail joints, the O. F. Jordan Co., Chicago, had a self-propelling machine, fitted with a timing device to apply the oil at regular intervals, according to length of rail.

Three tie-tamping machines were shown by the Ingersoll-Rand Co., the Syntron Co., and the Electric Tamper & Equipment Co. This last company had also a ballast cleaning machine mounted on a car and having blades which work between the ties. The McWilliams ballast "mole" machine, exhibited by the Railway Maintenance Co., Pittsburgh, crawls along between the tracks, digging up the ballast in front, carrying it back to a screen and depositing the cleaned ballast at the rear. For digging foundation holes for telegraph poles and fence posts, the Buda Co., Harvey, Ill., had the Buda-Hubron drill, mounted on a small truck with a 12-hp. gasoline engine. A weed cutting and ballast dressing machine was shown by the Gannon Weed Cutter & Track Dresser Co., Farmington, Minn.

Among the numerous rail, joint, frog and switch exhibits was the Morgan sliding-wing frog of the Mechanical Manufacturing Co., Chicago. The two wings are connected and have a lateral sliding motion on a base plate, but no springs are used. The first wheel entering the frog pushes the wing rails over, so as to give a continuous rail for the following wheels, the wings remaining in this position until reversed by a wheel on the other track. Several forms of fencing were shown, and the Cullen-Friestedt Co., Chicago, showed a model of a yielding barrier gate for the protection of drawbridges and highway crossings. Different forms of tie-spacing and track-lining tools were shown, and the Ramapo-Ajax Co., Hillburn, N. Y., had a screw-operated device for spreading rails where the joint gap is too small. A track spike having a projection on the back of the head, to rest on the tie when the spike is driven home, was shown by the Superior Spike Co., Chicago. Power-operated rail drills, nut wrenches, spike drivers and other tools were shown by the Ingersoll-Rand Co., Sullivan Machinery Co., and Woolery Machine Co.

The National Railway Appliances Association, which arranges the annual exhibitions, elected officers as follows: President, L. E. Weidman, Frog & Switch Manufacturing Co., Carlisle, Pa.; vice president, A. L. Greensbaum, O. F. Jordan Co., East Chicago, Ind. The secretary, C. W. Kelly, of the Kelly-Derby Co., Chicago, was re-elected.

Russian Exhibit of Waterworks and Sanitary Equipment in May

In connection with the conferences of sanitary and waterworks engineers to be held in the city of Kharkov, Russia, May 8-15, 1927, there is planned an extensive exhibit of equipment. However, in view of the limited space available, it is requested that where possible only models of machinery and charts, drawings, photographs, catalogs and other such material be used. The exhibit will provide American manufacturers an opportunity to bring their products to the attention of the market in Russia.

In addition to the sanitary and waterworks engineers, representatives of the government, of universities, schools and other scientific bodies are invited. There will be the following departments or sections of the exhibit:

1. Waterworks (city, village and railroad).
2. Sewer systems and sewage disposal plants.
3. Incineration, including garbage disposal.
4. City planning.
5. Municipal improvements.
6. Abbatoirs and allied industries.
7. Baths and bathing establishments.
8. Fire fighting apparatus.
9. Sanitation and hygiene in and about living quarters.
10. Heating and ventilation.
11. Construction machinery.

Further information can be obtained from the Amtorg Trading Corp., 165 Broadway, New York City.

Business Notes

THE HILL CLUTCH MACHINE & FOUNDRY CO., Cleveland, Ohio, recently appointed Charles C. Phelps, 473 Getty Ave., Paterson, N. J., as sales engineer for the New York metropolitan and northern New Jersey district.

JOSEPH G. WORKER has been appointed general sales manager and a member of the board of directors of the American Engineering Co., of Philadelphia, marketers of Taylor stokers. Lo-Hed electric hoists, Juruick commercial refrigeration units, and the A-E-CO line of yacht, ship and cargo-handling machinery. Mr. Worker during the past five years has been assistant to the president. For 15 years prior to that he was associated with the Westinghouse companies and for the last five years of this period was manager of the stoker section of the Westinghouse Electric and Manufacturing Co. at East Pittsburgh.

A. B. WILDER, manufacturer of highway equipment, Minneapolis, Minn., has acquired control of the Stockland Road Machinery Co. and the Lyle Culvert Co., both of that city. Associated with him in the active management of both companies is C. Sivright, vice-president and general manager of the Stockland company and vice-president of the Minnesota State Fair Association. Aggregate assets of both companies are said to total over $1,500,000. The Lyle Culvert Co. was organized by Mr. Wilder in 1905. The Stockland Road Machinery Co. was also organized in 1905 and was acquired in 1920 by the Lyle company, which does a large domestic and export business in road machinery. Two new units were recently added to the company's main plant to take care of its increasing business.

ALBERT BALL, chief mechanical engineer of the Sullivan Machinery Co. for nearly fifty years, died at his home in Claremont, N. H., Feb. 7, at the age of 91 years. A man of unusual inventive faculty and of keen mechanical sense and high ability, he possessed a genial and friendly personality which endeared him to a wide circle. Mr. Ball was born in Boylston, Mass., May 7, 1835. His schooling ended at the age of 16 years when he became apprentice in the machinist trade. His first employment was with L. W. Pond, at Worcester, Mass. In 1863 he brought out his first outstanding invention, a combined repeating and single loading rifle, and in the same year Mr. Ball perfected a polishing machine capable of polishing flat surfaces. Mr. Ball was sought out by E. G. Lamson, of the firm of Lamson, Goodnow & Yale, manufacturers of machinery, of Windsor, Vt. Mr. Lamson engaged Mr. Ball's services and the company manufactured the Ball gun, many of these firearms being sold in Germany and used by the Prussian army in the war against Austria. It was while Mr. Ball was with the Windsor firm that he invented and manufactured the first cartridge greasing machine, a machine that afterward came into general use in American and European arsenals. This invention came about as the result of Mr. Ball's visit to the Springfield, Mass., arsenal for the purpose of discussing contracts for the Ball rifle. Mr. Ball went to Claremont in May, 1868, to become affiliated with the J. P. Upham & Co., machine shop, which later became the Sullivan Machinery Co., the town's largest industry. He held the office of chief mechanical engineer with the Sullivan and the parent concern for nearly fifty years, retiring July 1, 1914. It was after he become associated with the Sullivan Machinery Co. that his full power as an inventor was attained. He was responsible for the development of many important improvements in mining and quarrying machinery; among these are the dia-

mond core drills for mineral prospecting and test borings; direct acting steel channeling machines for quarrying; rock drills and drill mountings embodying distinctive features and improvements; air-driven coal pick machines; quarry bars; mining columns and tripods and many others.

New Developments

Builds Two-Batch Truck for 27-E Paver Work

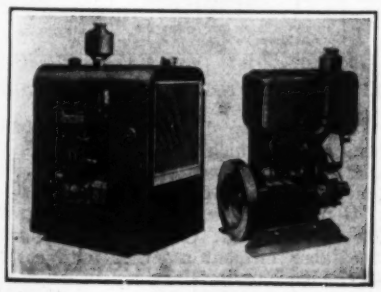
Based upon very definite ideas of proper design, a new two-batch truck has been designed by the Hug Co., Highland, Ill., which is especially adaptable for 27-E paver work. Model "HD6" has a maximum capacity of 10,000 lb., and is operated by a 6-cylinder Buda engine with a rated speed of 30 m.p.h. loaded.

As on other Hug trucks, the dual tire adapter is used so that dual tires can be mounted on the same wheel

used for single tires, and the unit pressures on the subgrade thus reduced. The adapter also assures perfect alignment of the front and rear wheels. It is claimed to even out subgrade ruts and reduce subgrade maintenance. A new feature on the truck is specially designed spring drive which cushions the wheels, axle shaft, driving mechanism, gears, clutch and engine. The body is 6x8 ft., 15½ in. deep, with 9½-in. side boards, and is equipped with a hydraulic under-body hoist.

New Line of Two Cylinder Engines Features Many Refinements

The new two-cylinder engines of the Novo Engine Co., Lansing, Mich., are made available in three sizes—6, 9 and 12 hp. All use 180-degree opposed throw counterbalanced crankshafts and are built either hopper or radiator



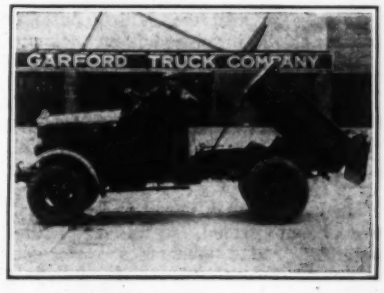
cooled. They are claimed to be the only two-cylinder engines with Timken tapered roller main bearings on both the crank and drive shafts. Another feature is the independent power take-off shafts having four speeds and a right- or left-hand direction of rotation. There is a drive take-off on both sides, magneto and carburetor always being away from the machine being operated. An automatic impulse starter is used on the magneto, making the engine easy to start. Handhole plates are provided for inspection of connecting rods and oil pump. The machines always crank right-handed and are built with an especially low overall height.

Improved Cold Patch Material Will Not Freeze

The cold patch material designated as No. 1, manufactured by the Headley Good Roads Co., Philadelphia, is a material for spring and summer use and is subject to freezing in the winter. The company has previously supplied No. 6 material, a cutback asphalt which is not affected by freezing weather, for winter use. This year it has developed a new material Viafalt which is claimed to have all of the high qualities of its Headley No. 1 with the added advantage that it may be used throughout the entire year. It is an asphaltic emulsion compounded from Mexican asphalt. It requires no heating and may be mixed by hand or by machine.

New 1½-2 Ton Truck with Road Builder's Body

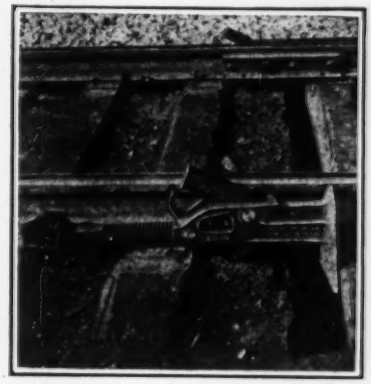
A new 1½-2 ton truck of 122½-in. wheelbase has recently been announced by the Garford Truck Co., Lima, Ohio, and is illustrated here equipped with a gravity dump body of all steel construction manufactured by the Superior Body Corp., Marion, Ind. The body may be had in sizes of 30, 36 and 41 cu.ft.



The important features of the new truck are four wheels on pneumatic tires, giving a lower loading height, better appearance achieved by new design radiator and the following of a stream line idea, an efficient cooling system, three point spring chassis and a comfortable driver's compartment. The truck has four speeds forward and one reverse. It uses a pressed steel 6-in. channel frame with I-beam drop front axle forged in one piece. The truck is also available in 144-in. wheelbase equipped with a standard hoist and 1½-cu.yd. dump body manufactured by Heil Co., Milwaukee.

Tie Spacer for Use With Jack

A new type of tie spacer for use with a track jack has been developed by the Duff Mfg. Co., Pittsburgh, Pa. The tie spacer is shown in the accompanying illustration, also the method of using it. It can be used with any make of track jack, is simple and of strong construction, and can be easily placed on either rail. In spacing ties, the head of the jack is placed against the



side of the tie spacer and the foot of the jack against the tie to be moved. A feature of this method of spacing is that only the tie to which the jack is applied will be moved.

This company has put two new track jacks on the market, one short jack and one long jack, both of 15 tons capacity. Both jacks have a suspended pawl which eliminates the use of a separate tripping device, the lower or short pawl serving as such.

Manufacturers and Trade Associations

Calendar

Annual Meetings

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual Meeting, White Sulphur Springs, West Va., March 21-23.

SOUTHERN PINE ASSOCIATION; New Orleans; Annual meeting, New Orleans, March 22-23.

HYDRAULIC SOCIETY, New York; Annual meeting Chicago, March 25, 1927.

NATIONAL LIME MANUFACTURERS' ASSOCIATION, Chicago; Annual meeting Chicago, April 28-29.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

New Publications

Trickling Filter Underdrains—WHAT CHEER CLAY PRODUCTS Co., What Cheer, Iowa, describes its patented underdrain tile for use in the trickling

filters of sewage disposal plants. Drawings are given showing sections of the tile in place, and a number of illustrations show the manner in which the underdrains are placed operate in the plant.

Grading Equipment — EDWARD J. JACKOBOICE, 136 Mount Vernon Ave., Grand Rapids, Mich., has published a 12-page catalog describing the "Monarch Road Maintenance Machine," which is a planing and scraping blade with the necessary operating mechanism designed to attach to a motor truck.

Sewage Screens—SANITATION CORP., New York City, devoes a new booklet to a photographic story of the progress in the work performed by the company during its past period of growth. Supported by a suitable amount of text are given many illustrations of water works plants, sewage plants and other installations where the company's screens, pumps and apparatus are used.

Large Highway Culverts — ARMCO CULVERT & FLUME MFG. ASSOCIATION, Middletown, Ohio, has issued a new bulletin under the title "Applying Culvert Simplicity to Highway Bridge Requirements." The booklet is a discussion of the use of large diameter culverts in their use for bridging highways across small streams. A number of illustrations are given which furnish an idea of the use to which such large culverts have already been put in this connection.

Fireproof Construction — UNITED STATES GYPSUM CO., Chicago, has issued five new bulletins devoted to its different construction products of fireproof material. A 50-page booklet gives architectural data on "Pyrobar" roof construction. An 18-page catalog gives architectural information on "Pyrofil" roofs and floors. A third bulletin describes the Pyrobar floor voids used with concrete joist systems of floor construction. The last two bulletins are devoted to Structlite (structural gypsum), the first devoted specifically to floors and roofs, the latter showing its adaptation to industrial building. All of the booklets contain line drawings of details, information as to installation and many photographs showing the three different types of gypsum products in actual use on diverse construction operations.

Carbon Monoxide—B. F. STURTEVANT CO., Boston, Mass., has published a 30 page bulletin, No. 345, devoted to carbon monoxide asphyxiation and its prevention. It has been published primarily as a warning to motorists and for pointing out methods of preventing carbon monoxide from accumulating. Sturtevant fans as used in both private and public garages are illustrated and described.

Elevators — WARNER ELEVATOR MFG. CO., Cincinnati, has prepared a 12-page booklet containing elevator specifications as recommended by it as a guide for architects and engineers. The specification covers all details of an elevator installation.

Business Side of Construction

Facts and Events that Affect Cost and Volume

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Mar. 17, 1927	$18,834,000	$25,403,000	$44,237,000
Mar. 10, 1927	27,407,000	54,796,000	82,203,000
Mar. 18, 1926	20,805,000	22,434,000	43,239,000
Heaviest Week			
1927, Mar. 10	27,407,000	54,796,000	82,203,000
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
Jan. 1 to Date			
1927	169,047,000	362,932,000	531,979,000
1926	182,131,000	372,896,000	555,027,000

Living Cost 75 Per Cent Above 1913 Level

Construction Labor at Higher Point Compared with Base Year Than Prices of Materials

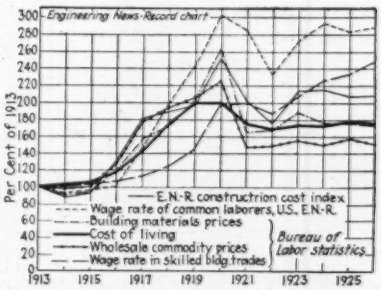
THE cost of living as expressed in the form of an index number based on the 1913 level as 100, is here compared with other elements of general cost, including construction materials and labor combined; building labor and materials separately; skilled building trades, as distinguished from pick and shovel or clean-up men; and prices of commodities sold at wholesale.

It will be noted that cost of construction and that of labor (both grades), are above the cost of living line. This has been true of most of the curves, since 1916.

During the war years and the post-war boom period, wages of skilled building trades mechanics were considerably below prices of materials, with both expressed in percentages of their respective 1913 levels. In the 1921 depression period, however, these lines crossed, with the result that at present the skilled wage curve points sharply upward, while that of materials is turning in the opposite direction.

Ten years ago materials cost considerably more than men, according to these figures, while today the spread between the two is even greater, with the advantage strongly in favor of labor. The fact that wholesale commodities have shown no marked tendencies to advance during the last five years has been an additional boon to the wage earner.

When it is considered that the labor costs depicted in this chart are based on the rate per hr. for both skilled and unskilled men and also that construction workers are subject to unemployment during the months of December, January and February of each year in the northern half of the country, the yearly earnings in these particular trades may not be greatly in excess of those in other industries.



LIVING AND OTHER COSTS COMPARED

The situation during 1925 and 1926 was one in which general construction costs were midway between materials prices and wages of skilled labor.

General construction cost as shown by the *E. N.-R.* Cost Index includes the labor element together with costs of the basic materials.

Big Buildings Form Bulk of Contract Total

Boom Due Largely to Additional Commercial Floor Space Necessitated by War-Time Industrial Expansion

The need for big buildings, that is, structures worth $150,000 or over, exclusive of industrial plants, has been greater than the requirements for any other form of construction during the last seven years, according to data gathered by *Engineering News-Record*.

In the accompanying diagram, it is shown just how large a portion of total construction value was devoted to commercial buildings during the years 1913 to 1926, inclusive.

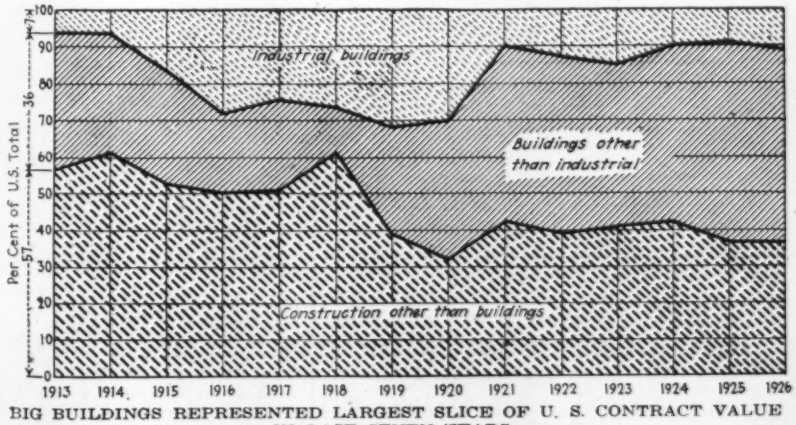
When industrial expansion was at its height, that is, between the years 1914 and 1921, the amount of commercial building was comparatively small.

During the building boom years, 1922 to the present time, industrial construction occupied a level about on par with the 1913-14 period. The heavy swath in the diagram, allotted to buildings other than industrial, for the years 1920 to 1926, inclusive, indicates quite clearly that the need for this additional commercial floor space was largely due to the increased plant capacity of the period beginning with the World War and ending with the depression which followed the post-war inflation.

The term buildings other than industrial, includes commercial, institutional, educational, religious, or public structures, as distinguished from those of a strictly manufacturing nature.

The chart shows the situation up to and including 1926. Since then, however, figures for January and February of the current year indicate that practically the same conditions hold as in 1926. January industrial contracts were 12 per cent; buildings other than industrial, 61 per cent; and construction other than buildings, 27 per cent of the total value for the month. February figures ran 5 per cent, 69 per cent and 26 per cent, respectively.

Since March 1, 1927, the tendency has been to fall short of the comparable period of 1926 by a very slight margin. This applies more to money value of contracts let on large engineering construction projects than it does to actual number.



BIG BUILDINGS REPRESENTED LARGEST SLICE OF U. S. CONTRACT VALUE IN LAST SEVEN YEARS

Ready Next Week

ENGINEERING NEWS-RECORD

Construction Costs

For the last two years *Engineering News-Record* has been searching its files and raking all other authentic sources for construction cost data—from 1910 to date. The result is its 48-page manual: *"Engineering News-Record Construction Costs."*

Here you have over a period of seventeen (17) years the high-low average prices of basic materials and the rates paid the building trades in a number of centers . . .

The Engineering News-Record Construction Cost Index Number (the authoritative gage of general construction cost) has been carried back to *1903*, and is here given with extended treatment, including sixteen charts comparing it with other indexes . . .

Included are complete tabulations of actual prices bid on fifty (50) different jobs in 1926. Here you have exactly what contractors—those who actually take the risk—think of *current* costs . . .

Engineering News-Record thinks so highly of this carefully compiled and varied collection of construction costs that it wants it to get into the hands only of those who can use it and properly appreciate it. Therefore a nominal charge is made.

For one dollar $1 *it is yours!*

Cash may be sent at our risk. Address:

Construction News Editor,
ENGINEERING NEWS-RECORD
Tenth Avenue at 36th Street,
New York, N. Y.

Total value of awards, all classes, for the entire country, Jan. 1 to March 17, 1927, is 4 per cent under that for the corresponding period last year, see table on p. 468.

Public work shows the heavier drop, that of 7 per cent for the period mentioned, while private projects reveal a loss of 3 per cent, compared with the first eleven weeks of 1926.

Special Tabulation of Unit Prices
Steel Reinforcing Bars

The following unit prices are included in the low bidders' estimates on various water-works projects:

Location	Date	Lb.	Price per Lb.
Tulsa, Okla.	Sept., 1922	481,600	$0.045
Memphis, Tenn.	Oct., 1922	1,200,000	.036
Poughkeepsie, N. Y.	Apr., 1923	1,200	.10
Mariemont, O.	Apr., 1923	1,000	.08
Cleveland, O.	May, 1923	2,812,000	.05
Cleveland, O.	June, 1923	500	.10
Cleveland, O.	July, 1923	7,000	.10
Springfield, Ill.	Sept., 1923	30,500	.05
Portland, Ore.	Oct., 1923	4,000	.0872
New Bedford, Mass.	Oct., 1923	23,000	.109
Fairmont, W. Va.	Feb., 1924	205,000	.0525
Kansas City, Mo.	Mar., 1924	100,000	.05
Albany, N. Y.	Apr., 1924	385,000	.043
Springfield, Mass.	May, 1924	200,000	.06
Providence, R. I.	May, 1924	900,000	.06
Denver, Colo.	June, 1924	150,000	.06
Denver, Colo.	June, 1924	1,510,000	.07
Kent, O.	June, 1924	190,000	.0487
Staunton, Va.	Aug., 1924	40,000	.08
Kansas City, Mo.	Mar., 1925	60,000	.06
Ashland, Pa.	Apr., 1925	36,000	.08
Hartford, Conn.	Sept., 1926	90,500	.07

The following apply to dams:

Location	Date	Lb.	Price per Lb
Starved Rock, Ill.	Feb., 1923	162,000	$0.03
Merced, Calif.	Nov., 1923	85,000	.03
Sedalia, Mo.	Mar., 1926	52,000	.045
Philadelphia, Pa.	June, 1924	20,000	.07
Sun River, Mont.	Aug., 1926	350,000	.025
Roland, Calif.	Sept., 1926	1,500,000	.013
Golconda, Ill.	Oct., 1926	136,270	07
San Diego, Calif.	Feb., 1927	1,130,000	.042

Weekly Construction Market

SINCE spring building activities show a trifle more than seasonal intensity at the present time, basic materials are assuming added firmness, despite the plentiful supply in all lines. This is speaking of the country as a whole, inasmuch as several exceptions of a local nature appear.

Compared with a year ago, prices in the New York district are higher for the following materials: lime, crushed stone, hollow tile, cast-iron pipe, reinforcing bars, steel shapes, and linseed oil. Declines are noted in cement, sand, steel pipe and white lead.

New York City differs from contiguous territory in that prices are at year-ago levels for tile, steel reinforcing bars, and structural shapes, while linseed oil and cast-iron pipe are lower than at this time in 1926. In lime, prices of finishing (lump and hydrated) are the same as those of a year ago in Manhattan, while common lump is higher and hydrated common under the corresponding period last year. Sand, steel pipe and white lead are at March, 1926, levels in this city.

In the minor materials, prices are above those of a year ago in pine two-by-fours, red cedar shingles and slate surfaced roofing. New York City prices on the last mentioned material are unchanged from the 1926 level on strips and lower on the single shingles. Lower prices obtain in Douglas fir two-by-fours, common boards (1-in.) and roll roofing materials of various descriptions used mostly on small buildings.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montrea
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	$3.15	$3.80
Structural rivets, 100 lb	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	....
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	3.10	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	54.25%	41%	42@53.8%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	47.60	42.75	56.00	46.20	48.50	62.00	47.00	55.00	62.50
Concreting Material									
Cement without bags, bbl	2.35@2.50	2.35	2.05	2.05	2.22	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	61@63	34.00	56.00	40.50	—38.75	33.25	27.00	25.00	50.00
Lime, finishing, hydrated, ton	18.20	—22.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	—20.40	+12.00	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.076	.072	.085	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1112	.0895	.112	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal	.81¾	+.90¾	1.10	.80	.93¾	—1.02	.91	1.12	1.03
Common Labor									
Common labor, union, hour	.90⅞	.30	.....	.90	.....	.50@.55	.60	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.....	.45@.60	.40@.45	.50	.....	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06½; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Mar. 3, the next on Apr. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. **Sand**, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.81). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots.

Unit Prices

For actual prices bid on materials in place at various construction jobs throughout the country, see pp. 84B-86 of this issue, following Construction News.

On Mar. 1, 1927

E. N.-R. Construction Cost Index Number 208.80

E. N.-R. Construction Volume Index Number 182

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month